AF INSTITUTE OF TECHNOLOGY

RISK MANAGEMENT ASSOCIATED WITH WEAPON SYSTEM WARRANTIES AND COMPONENT BREAKOUT

THESIS

Raymond B. Zaun, B.S.C.E.
Captain, USAF

AFIT/GSM/LSY/88S-29

DEPARTMENT OF THE AIR FORCE

AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Systems Management

Raymond B. Zaun, B.S.C.E.

Captain, USAF

September 1988

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AFIT/GSM/LSY/88S-29

Acknowledgements

I would like to take this opportunity to express my sincere appreciation to my thesis advisor, Lieutenant Colonel Jeffrey J. Phillips, for his encouragement, support, and professional guidance. Sincere appreciation is also extended to all the people, too numorous to mention by name, in the Deputy for Propulsion Office of Aeronautical Space Division. These people were unselfish with their time, and their expertise proved invaluable.

Most importantly, I wish to thank my wife Lisa. Throughout this research, she has remained my best friend, and she has become an editor. She has endured the hardships associated with my working many late nights, and I thank her from the bottom of my heart.

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Abstract

The objective of this research was to investigate the relationship between component breakout and warranty coverage. To accomplish this objective a review of the literature of these two areas was completed. After this review, unstructured interviews were conducted with several experts in the fields of component breakout and warranties. These experts identified eight factors which influence warranty costs. Data for these factors was obtained from the Recoverable Consumption Item Requirement Computation System (D041) and from data base fourteen of the INFOCEN system. These warranty cost factors were analyzed with the intention of relating these factors back to component breakout.

This analysis was made using regression analyis. The statistical package SAS was used as the primary tool for the regression analysis. The regression analysis used repair and acqusition costs as the dependent variables to be modeled. The regression analysis on these eight factors resulted in a model which included only acquisition costs. This analytical model was tested and found inadequate. To improve the aptness of the model, transformations of the acquistion costs were done. The model produced from these transformations used the square root of the acquisition

costs. The new model increased the aptness, but the normal distribution was still not the correct distribution to use for cost data. Therefore, one of the recommendations was to model the data with a statistical distribution other than normal. Another of the recommendations was to investigate the data collected on warranty repair costs.

RISK MANAGEMENT ASSOCIATED WITH WEAPON SYSTEM WARRANTIES AND COMPONENT BREAKOUT

I. Introduction

GENERAL ISSUE

Defense spending is a popular subject today. It is not uncommon to pick up a newspaper and read about cost overruns on defense programs or overspending on a defense related item. The Department of Defense (DoD) has always been concerned with controlling costs. However, with the increased public awareness, increased technology, and increased cost; DoD has increased its emphasis on finding new ways of decreasing costs without causing damage to national defense. Component breakout is one contractual way to control increasing defense costs and still maintain an effective defense posture.

However, there are risks associated with a component breakout program. One risk is loss of warranty coverage of components or systems containing the components. Lost warranty coverage risks may include liability for correction of deficiencies in the components or systems which were broken out. Lost warranty coverage may also include correction of warranted contractor furnished equipment,

damaged as a result of the failure of the broken out component or system. Program managers must be aware of all the risks accepted by the program office before the breakout decision is made.

DEFINITIONS

Component breakout is a particular method of contracting used by the Department of Defense to purchase weapon system components which were previously bought by prime contractors directly from the manufacturers or subcontractors. Those components are then provided to prime contractors for incorporation into weapon systems (10:80). A warranty is a contractual clause in which contractors are held liable for correction of deficiencies in certain areas, such as performance, quality and workmanship, for a specified length of time after contractors have delivered the items (3:9).

JUSTIFICATION

As technology advances and the complexity of weapon systems increases, the costs of the weapon systems also increases. From 1982 to 1986, DoD spent nearly two trillion dollars for procurement of equipment and supplies (9:1). Because of these large dollar amounts, the government should closely control these costs. One approach used since the late 1950's is component breakout. "Component breakout

decreases weapon system costs through elimination of prime contractor surcharges such as profit, growth and usage, and material handling" (9:1). The DoD policy on component breakout is as follows:

> 1. Whenever it is anticipated that the prime contract for weapons system or other major end item will be awarded without adequate price competition, and the prime contractor is expected to acquire a component without such competition, it is Department of Defense policy to break out that component if:
>   (a) substantial net cost savings will probably be achieved; and
>   (b) such action will not jeopardize the quality, reliability, performance or timely delivery of the end item.
> 2. The desirability of breakout should also be considered (regardless of whether the prime contract or the component being acquired by the prime contractor is on the basis of price competition) (1) from greater quantity acquisitions or (2) from such factors as improved logistics support through reduction in varieties of spare parts found economies in operations and training through standardization of design. Primary breakout consideration shall be given to those components of the end item representing the highest annual acquisition costs and offering the largest potential net savings through breakout [7:17202-2].

Despite this type of DoD guidance there are still problems with component breakout. In some cases there seems to be a level of indifference which precipitates a willingness to ignore component breakout as a possible cost cutting tool (9:7).

There are costs and risks involved when using a component breakout system. One risk deals with the effect on

warranty coverage associated with the component being broken out or systems associated with that component. A method of dealing with this risk in the past may have been to dismiss the warranty coverage altogether. However, in 1985 a law was passed requiring that any item purchased by the government must be covered by a warranty. The Air Force Product Agreement Center wrote in their Task Force report of January 1986 that the impact of warranties on the operational logistics systems needs to be assessed with particular emphasis on the cost-benefit analysis and related areas (2:6). One area in which the cost-benefit relationship associated with warranties must be investigated is component breakout decisions.

RESEARCH OBJECTIVE

Concerning weapon system acquisition, military managers must deal with many congressional objectives. One major objective states that the Department of Defense must decrease costs of weapon systems. Component breakout may be one way of controlling defense costs while maintaining an effective defense posture. Program managers should be aware of the risks assumed by program offices before a breakout decision is made.

SPECIFIC PROBLEM

Another congressional objective states that warranties shall be used on DoD acquisitions after 1 January, 1985 (2:7). Conflicts arise between these two congressional objectives when a component breakout decision is made that totally or partially eliminates warranty coverage on that component or systems associated with that component. This research will focus on the variables associated with warranties. These variables will explain the risks associated with elimination of weapon system warranties due to component breakout within DoD.

INVESTIGATIVE QUESTIONS

Three investigative questions need to be answered. The first deals with identifying the programs with experience with warranties and component breakout. The measurement questions are the following:

1) What program offices utilize component breakout?

2) Are warranties in place on the programs in the program office?

3) What data is available on the warranty claims?

4) What variables contribute to the warranty costs?

The second investigative question deals with quantifying the variables identified by the first set of mea-

surement questions. The measurement questions to be answered here are as follows:

1) Are these variables independent or dependent?

2) What are the values associated with the identified variables?

3) What are the units associated with the identified variables?

When these questions have been answered, this research will allow program managers to better understand warranty costs.

The final investigative question deals with the generalization of the data collected in the the first two investigative questions. The measurement questions to be answered for this section are as follows:

1) What are the best models for the previously identified dependent variables?

2) How do these models relate to component breakout in a way to help decision makers?

When these questions have been answered they will result in a model which can effectively predict the overall cost of a warranty and be used as an aide to the person making the component breakout decision.

SCOPE

This research focuses on the component breakout and product warranties in the Department of Defense. The warranty research deals only with the warranties in DoD,

which may be quite different from warranties in the commercial sector. The primary difference is in the degree of liability accepted by the manufacture. In the DoD arena the primary contractor designs weapon systems to a given set of constraints, while in the commercial sector the manufacturer sets up the constraints under which the product is warranted. The research will be conducted entirely based upon data collected from Aeronautical Systems Division (ASD), because ASD accounts for more than 60% of AFSC's total breakout activity (8:8).

II. Literature Review

OVERVIEW

This chapter will establish a foundation for the understanding of component breakout, warranties and their relationship. To accomplish this some history pertaining to component breakout and warranties will be presented, then present policies and current views on the two subjects will be discussed.

COMPONENT BREAKOUT

History. In the 1930's and 1940's weapon systems were so simple that the government did most or all of the integration work on a weapon system. As complexity increased, the government began to let the prime contractors contract with subcontractors to do some of the integration work (9:10). In the late 1950's, after seeing weapon system costs increase dramatically, the Department of Defense (DoD) began to look at ways of contractually controlling these costs. The Army recognized component breakout as a way of doing this (9:11). In the 1960's the Air Force and the Navy began component breakout programs. While it never became a requirement, component breakout became a normal part of the procurement process in the 1960's. After a decline in interest during the 1970's, emphasis on

component breakout has increased in the 1980's primarily because of the increased concern over costs and overspending (9:13-17).

Policy. The Armed Services Procurement Act (ASPA) of 1947, Title 10 of the United States Code, is the basic legislation governing all post World War II procurement. The ASPA has had three major changes since 1947, with the most recent being the Competition in Contracting Act (CICA) of 1984 (5:32). The CICA was a reaffirmation of the congressional belief in competition. The intent of Congress in enacting CICA might be summarized by using the words of the House Report 98-1157: "any effort to reform government procurement practices must start with a firm commitment to increase the use of competition in the federal marketplace" (5:47).

The CICA signified a movement by DoD to go from sealed bids, with no negotiation, to procurement by full and open competition. DoD recognized that with increased technology, proposals may not have sufficient detail and may require some discussion (11). The CICA gives the only exceptions accepted for not using the full and open method of contracting (14:6.2-6.5).

Component breakout should be considered for components which represent the highest annual procurement costs for the weapon system and offer the greatest potential for cost

savings (10:4). Breakout eliminates the middleman role of the prime contractor. Some of the costs avoided with this elimination include contractor's overhead, direct labor costs, and profit (15:11).

Current Views. Component breakout identifies items which were Contractor Furnished Equipment (CFE), where the contractor is responsible, and makes them Government Furnished Equipment (GFE), where the government is responsible. Breakout is an effective way to reduce acquisition costs by doing the following: "1) eliminating prime contractor add-on or flow through costs such as overhead, administration, and profits or 2) injecting competition into the acquisition process reducing component price" (15:1). There are two types of component breakout. The first is by direct noncompetitive purchase from the subcontractor, and the second is by competitive purchase (10:2). The former results in a single source, while the latter results in the development of several sources.

There are many factors requiring consideration before breaking a component out from a weapon system. The Federal Acquisition Regulation gives several of these factors with design stability being the most important, according to Major John Wayne (15:3). If the design is not stable, the program manager must be concerned about configuration changes. Because of this fact, component breakout is most

suited for follow-on lot production buys (15:3-9). Other factors which need to be considered are program risk (the amount of risk taken by the contractor versus the risk taken by the program office), manpower requirements, and warranty effects. Of these factors, program risk is the most important (9:39). This also seems to say that component breakout is most suited for a follow-on production program.

There are costs associated with component breakout, some of them tangible and some of them intangible. Tangible costs include the following: data procurement costs, storage costs, manpower costs, and increased contract requirements. Intangible costs include increased program risk, schedule delays because of delivery slips, and component failures (15:10-12).

A program manager must be able to identify and carefully consider the benefits and the costs associated with breaking out a component before an intelligent decision can be made. One of the considerations the program manager must look at is the warranty coverage on the component and systems affected by the components.

WARRANTIES

History. Warranties have been used in DoD for many years. In 1964 DoD issued detailed instructions on what a

warranty was to look like in a firm fixed price contract; these instructions were included in the Defense Acquisition Regulation. In 1967 the instructions were expanded to include a "correction of deficiencies" clause (8:25).

A significant change occurred in 1983 with the Andrews Amendment to the DoD Appropriations Act. Senator Andrews, of North Dakota, wanted a warranty similar to commercial warranties. This amendment to the Appropriations Act became Section 797 of Public Law and made warranties a requirement (11).

Policy. Between 1984, when Senator Andrews introduced his amendment, and 1985, when it finally became law, several changes were made. In 1984 the warranty was to ensure that the weapon system was designed and manufactured to meet the government's requirements. The component or weapon system was also to be free from defects in materials and/or workmanship. In 1985 a Section (Section 2403) was added to Title 10 of the United States Code stating that items delivered to the government also had to have a warranty on the performance parameters in the contract (2:6).

Current Views. A warranty is a means of ensuring a certain level of performance for a specified period of time after the weapon system is delivered. There are two categories of warranties: 1) free replacement and 2) pro-rata. The free replacement warranty provides for free replacement

of the warranted item before the end of the specified warranty period. The pro-rata warranty provides for replacement of the item at a reduced cost, depending on the amount of time the item has been in service. Many times the pro-rata warranty includes a free replacement period prior to the prorating period (4:259).

Warranties are now required by law but are not to be used without first ensuring that there is a benefit to the warranty. If the warranty is not going to be cost effective, a waiver should be processed. A waiver would allow the program to continue without a warranty. A waiver requires a cost analysis to be run (2:7).

Past cost analyses have yielded several findings. Warranties work better on components than on whole weapon systems. Warranties also work better if they are applied to components with a stable design and proven technology (8:26).

The length of the warranty will vary depending on the program and the type of warranty used. Warranty duration should be the most cost effective length of time to allow correction of as many defects as possible, up to the point where the benefits from correction at least equal the cost of the warranty. After this point, the warranty should be terminated (3:60).

Warranties provide a way for the government to protect itself against poor products; however, the contractor often limits his liability under the warranty clause. Most warranties will not be exercised if the warranted item fails in conjunction with a piece of Government Furnished Equipment, if improper maintenance procedures were used, or if the item was improperly handled (3:17).

The length and type of warranty should be studied carefully and modified to fit the particular program. If the warranty is structured correctly, it may serve to motivate the contractor to provide the government with a better product.

SUMMARY

This chapter examined two topics that are very important to the Department of Defense -- component breakout and warranties.

Component breakout has been used since the late 1950's and has strong congressional support today. The Competition in Contracting Act of 1984 is a primary reason why component breakout is used. Component breakout increases competition and saves the government money. Reduced costs are those added by prime contractors for the components it purchased from subcontractors.

There are also costs associated with managing a component breakout program. Services the prime contractor may

have been responsible for may be eliminated when the component is broken out. Another consideration is increased risk from reduced warranty coverage on the component or the weapon system. Warranties have been used in DoD since 1964. They are presently required by section 2403 to Title 10 of the US Code. While this law requires warranties, it recognizes that warranties should only be used if they are cost effective.

If implemented correctly, both component breakout and warranties can benefit the government by saving money. However, a program manager must learn to look at both the benefits and the costs associated with both of these areas before making any final decisions.

III. Methodology

OVERVIEW

This chapter describes the research methodology used to answer the investigative and measurement questions identified in Chapter I. This chapter includes a description of the data gathering process and the statistical analyses that was performed.

DATA COLLECTION

The data collection section of the research answered the measurement questions for the first two investigative questions. These measurement questions deal with the identification, classification, and value of the variables associated with warranties.

For the purposes of this research the population was restricted to the System Program Offices in Aeronautical Systems Division (ASD) listed in Table 1.

Table I

Candidate SPOs

1. Deputy for Tactical Systems (TA)
2. Deputy for Propulsion (YZ)
3. Deputy for F-16 (YP)
4. Deputy for Reconnaissance/Strike and Electronic Warfare Systems (RW)
5. Deputy for Strategic Systems (YY)
6. Deputy for Airlift and Trainer Systems (AF)
7. Deputy for B-1B (B-1)

These were selected based upon the study performed by Heitmann concerning identification and importance of factors in component breakout (9:28-34). This study explains the nature of the breakout programs in each of these program offices.

To find which of these offices had the most complete data on warranties, a group of experts was consulted using an unstructured interview. These experts included AFIT faculty and personnel from head quarters US Air Force Logistics Command (AFLC), Air Force Acquisition Logistics Center (AFALC), and ASD. Although the AFIT faculty are not practicing the duties of component breakout and warranties, they are familiar with the practices and policies in these areas. Each subject was asked to rank the seven program offices in the order of completeness of the warranty programs. The subject was also asked to give the variables that they thought would have the most effect on warranty costs. After these interviews, the most likely program office was contacted to identify what data was available. This provided the answer to the first investigative question.

Once the responses to these interviews was collected, the next step was to get appropriate data associated with the program and the variables identified by the experts. This data was obtained from the appropriate people within

the respective major program office(s) and was used to answer the measurement questions under the second investigative question.

DATA ANALYSIS

The data analysis evaluated the last of the investigative questions. This question dealt with what model would be the best for the dependent variables discovered in the data collection. The data collected is interval and ratio level data which allows the use of arithmetic mean and variance.

The significance level chosen was .01. This significance level takes into account the fact that pricing warranties and associated issues is a new area and allows for some error. This alpha level determines the region of rejection of the null hypothesis, which says that the the measured population is distributed in the same way as the theoretical distribution.

The next research phase was to construct a model of the costs associated with the risks. "A model is a representation of an object, system, or idea in some form other than that of the entity itself" (12:4). For this research the primary analysis method used was the regression analysis technique. The regression analysis required the extensive use of the statistics packages -- SAS and Power-

pack. SAS, through the use of PROC commands, gives the appropriate correlations, aptness analysis data and coefficient confidence intervals. Powerpack provided a method of obtaining the Z values required for the aptness checks. The modeling process also required the use of a simple spread sheet. VP Planner was used for this purpose.

The variables that could not be included in the modeling process were analyzed separately and the results will be discussed later in the research.

<u>SUMMARY</u>

This chapter discussed the methodology for collecting the data required to answer the investigative and measurement questions from Chapter 1. Research results, an analysis of the data, together with a more in-depth discussion of the statistics used, will be presented in following chapters.

IV. Findings and Analysis

Overview

The purpose of this chapter is to present the research findings resulting from the data collection and analysis performed by the researcher using the methodology described in Chapter III. This chapter is separated into three sections, each section illustrates a phase of research done to answer the third investigative question identified in Chapter I. The overall objective of this chapter is to answer the research objective identified in Chapter I.

Section I

Phase one of the research answers the first investigative question: Which of the seven programs identified in Table I (TA, YZ, YP, RW, YY, AF, and B-1) would be the best candidate for this research? As discussed in the methodology informal interviews were conducted with five experts. These experts came from AFIT, AFLC, and ASD. The experts were chosen for their knowledge of warranties. These interviews resulted in the identification of the Deputy of Propulsion (ASD/YZ) as the best candidate for this research. Warranties became mandatory on acquisitions made after 1 January, 1985, but ASD/YZ is the only System

Program Office (SPO) to have enough data with which to do an adequate analysis. The Heitmann research (9:33) showed that component breakout was either being used or will be used at a later date on the programs in YZ. For these reasons, ASD/YZ was chosen as the subject of this research.

When the F100-220 engine program was selected, the first step the researcher took was to review the warranty clause in the F100-220 contract. The warranty states that the contractor, Pratt and Whitney, is responsible if either of two situations occurs. The contractor is responsible if the engine does not operate in the aircraft as designed. The contractor is also responsible if the engine fails to operate for a stipulated period of time and if the Combined Engine Removal (CER) rate is greater than the rate the contractor put forth in the contract. The time period stipulated for the F100-220 engines is three years or 1400 Total Operating Time (TOT), where TOT is defined as the time in hours the engine operates above 260 degrees Celsius fan inlet turbine inlet temperature as measured by the engine monitoring system. The CER is the unscheduled engine removals plus the scheduled engine removals. The warranty also states that modules, components, and parts are to be free from defects in materials and workmanship. They are also to be free from anything which may cause any

of the parts to be defective or cause the engine to fail to meet its specifications. The remedy if there is a warranty claim is that the contractor is responsible for the total repair or replacement costs and that the repair shall be done in no more than forty five days. Some of the exceptions to coverage under the warranty clause include: foreign object damage (FOD), improper maintenance practices, acts of God, and breakout parts (1:215).

The next step was to find out what variables influence warranty costs. Through this researcher's experience and the discussions with the experts mentioned before the factors shown in Table I were determined to be the primary variables required to model warranty costs.

Table II

List of Factors Influencing Warranty Costs

1. Failed Part
2. Part Repair Costs
3. Part Acquisition Costs
4. Reporting Agency
5. Date Part was Serviced or Manufactured
6. Government Furnished Equipment (GFE) or Contractor Furnished Equipment (CFE)
7. Part Monthly Mean Time Between Failure (MTBF)
8. Part Cummulative Mean Time Between Failure (MTBF)

At the present time the only YZ program that has this type of data is the F100-220 engine program. Of the aircraft that the Propulsion SPO handles, only the F-15

Eagle has been tracking failures and flying times associated with the warranty. Therefore this research was conducted on only the F-15's with F100-220 engines. Data collection for the F100-220 engine warranty was started in June of 1986. For this research, the time period ends with February of 1988.

The determination of the program and the variables effecting warranty costs suffeciently answered the first investigative question.

<u>Section II</u>

The second research phase answered the second investigative question. This question dealt with the quantification of the variables identified in the first research phase.

After the variables were identified by the subjects and the program had been identified as the F-15's with F100-220 engines the data collection began. The data that was collected came from several different sources. The flying time on the engines was called Engine Operating Hours (EOH). EOH takes into account that the F-15 has two engines and that the engine operating hours should be doubled. This data was collected from the Supportability Group in YZ. The failures that were counted against the warranty were collected from a INFOCEN Air Force Data Base

14 (DB14) printout obtained from ASD/YZWC. This data base also included which part failed, the part number, the date the part failed, the last date of overhaul or the date of manufacture, the part number and whether the part was Government Furnished Equipment (GFE) or Contractor Furnished Equipment (CFE). The repair and acquisition costs were obtained from the Recoverable Consumption Item Requirements Computation System (D041), which is maintained by AFLC. These costs were assigned to the particular part by the National Stock Number which was cross referenced from the part number. All of the acquisition costs are estimated and all of the repair cost are calculated numbers. Several of the parts found in the INFOCEN data base could not be found in the D041 data base. To obtain these costs of these parts a linear regression analysis was run with the points obtained from the D041 data base. The linear regression equation that was used was:

$$y = .19x + 92.06$$

The acquisition and the repair costs in the D041 data base are not actual costs but were calculated and estimated by Logistics Command.

The INFOCEN report and the D041 data produced the values for the first four variables listed in Table II. The monthly Mean Time Between Failure (MTBF) and the cumulative MTBF were calculated by the researcher. The

researcher worked as a reliability and maintainability engineer in ASD for four years, and is qualified to calculate thes numbers. MTBFs are calculated by dividing the number of failures occuring in a certain time, by the amount of time accumulated during this time period. This research separated the failures by part number and month. Then this number was divided by the EOH for that month to produce a monthly MTBF. The failures were added together by part number and divided by the total EOH to produce a cumulative MTBF.

The entire data base is presented in Appendix A. The data base consists of 167 data points and 14 variables. There are two dependent variables: repair costs (REP) and warranty costs (WAR). There are also three independent variables in the data base, these are:

1. Monthly Mean Time Between Failure (MTBF)
2. Cumulative MTBF
3. Acquisition Costs (Price)

The item number, report number, the report control number (abbreviated R.CONT.), and the date discovered were used only for tracking purposes and were not used in the analysis. There are 44 different National Stock Number part numbers for 33 different parts. This means that some of the parts are functionally the same but are not interchangable. Of the 33 different parts six of them accounted for over sixty two percent of the recorded failures between

June of 1986 and February of 1988. These six were the divergent nozzle segment seal, the PS2 probe, the engine diagnostics unit (and the internal boards), the anti ice valve, the digital electronic engine control (and the internal boards), and the main fuel control. The other 27 had less than ten failures and many had only one failure during this time frame. The Thirty-third TAC Fighter Wing at Eglin AFB,Florida submitted 113 or sixty eight percent of the warrarty claims. The NAVPRO representatives submitted another nineteen percent, for a total of eighty seven percent of the claims. When a one appeares in the GFE column, it means that the INFOCEN report stated that part was GFE. This is a very general review of the data, the remainder of this chapter examines the more detailed statistical analysis of the data.

After the data was collected the variables had to be categorized as independent or dependent. Using the definition given by Devore (6:67) the warranty and repair costs were determined to be the only dependent variables to be analyzed. These two variables could be influenced by the other variables and may be dependent upon one another. The other variables; acquisition costs, monthly and cummulative MTBF; were determined to be independent variables.

The collection of the data effectively answers the second investigative question and the associated measurement questions.

Section III

The last phase of the research answered the third investigative question. This question dealt with finding the best model for the dependent variables,determined in the second research phase.

This phase of the phase of the research required extensive use of the regression methodology. A spread sheet and two statistics packages were used to accomplish the regression analysis. The spread sheet, VP Planner Plus, was used to do the data base functions and to produce the appropriate aptness plots. The two statistics packages were SAS and Powerpack. Powerpack was used to determine the Z values required for the aptness checks and the SAS package was used for the remainder of the regression procedure. The particular SAS and Powerpack programs are shown in Appendix B and C repectively.

The following is the general equation for a model:

$$Y = \text{BETAZERO} + \text{BETAONE}\ X_1 + \ldots + \text{BETAi}\ X_i + \text{EPSILON}$$

This equation states that a model can consist of any number of independent variables (X) which model the dependent variable (Y). This equation follows the general equation

for a line: $y = mx + b$, where m is the slope of the line and b is the y intercept. This equation has more than one independent variable, therefore, this equation would result in a hyperplane. In the case of the model, betazero is the y intercept and the beta coefficients (betaone, betatwo,...,betai) are the least squared estimates for the slope of the line which most effectively models the data. When the slopes are combined they result in the hyperplane.

Before the regression analysis can be employed for statistical reference, several assumptions must be made. The first assumption is that data points used here are representative of a larger population. The population for this research would be all of the DoD programs which have working warranties associated with them. The second assumption was that the population variance of the dependent variable in the model is equal for each set of values of the independent variable (homoscedasticity). The final assumption is that the error term, epsilon, is normally distributed with a mean of zero and a variance equal to dependent variables variance. As stated previously the betas are slopes of the the least squared hyperplane that best fits the data. The least squares estimator computes the plane of means that cuts through the n-space scattergram of the dependent variable values. Each of these as-

sumptions was evaluated when a particular model was determined to be a candidate.

After these assumptions were made, then the building of the model can begin. As stated before the primary tool used in the model building was regression analysis and SAS was the primary tool used for the regression analysis. The first part of the regression involved a correlation analysis which produced the means, standard deviations, the numerical sum, and the minimum and maximum values for each of the independent and dependent variables. This is referred to as an Analysis of Variance (ANOVA) table. Table III shows the ANOVA table for the five variables to be analyzed. Table III also shows the correlation matrix with the Pearson r correlations (top line) and the p-values (lower line). The r values are the primary concern here. The r values tell the degree of correlation between any two independent variables. This means that the matrix shown only considers the bivariat correlations and does not address any correlation which may exist between more than two variables. Consideration of the multiple correlation is very important in a multiple regression model. It is desirable to have a high amount of correlation between the dependent variable and one or more independent variables. However, very high correlation between the independent variables is not desirable. High amounts of correlation

Table III

ANOVA Table for the F100-220
Engine Data

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
REP	167	2901.644	6439.286	484574.5	7.000	26688.00
WAR	167	55367.554	16606.302	9246381.6	32057.880	67127.39
MON	167	1147.489	814.069	191630.7	102.500	3194.00
CUM	167	3005.766	4534.865	501962.9	102.500	30891.00
AQC	167	15849.905	36075.019	2646934.1	46.010	173069.44

PEARSON CORRELATION COEFFICIENTS / PROB > :R: UNDER HO:RHO=0 / N = 167

	REP	WAR	MON	CUM	AQC
REP	1.00000	0.15692	0.00586	-0.05879	0.93425
	0.0000	0.0429	0.9401	0.4505	0.0001
WAR	0.15692	1.00000	-0.36219	-0.23723	0.16888
	0.0429	0.0000	0.0001	0.0020	0.0291
MON	0.00586	-0.36219	1.00000	0.52047	-0.03089
	0.9401	0.0001	0.0000	0.0001	0.6919
CUM	-0.05879	-0.23723	0.52047	1.00000	-0.08382
	0.4505	0.0020	0.0001	0.0000	0.2815
AQC	0.93425	0.16888	-0.03089	-0.08382	1.00000
	0.0001	0.0291	0.6919	0.2815	0.0000

between the independent variables results in a problem known as multicollinearity.

To begin to investigate the multiple correlation effects another SAS procedure was used. This procedure produces every possible model between the dependent variable and the four independent variables. Tables IV and V show the results of these procedures. Table IV shows this output for the models of repair costs and Table V shows these models when the dependent variable is the warranty costs. There are four independent variables because when either the warranty costs or the repair costs were used as a dependent variable, the other was used as an independent variable. The Tables also show the R squared values for each model. This R squared value gives the amount of variance in the dependent variable which can be explained by the independent variables in the model. However, this SAS procedure still does not address the problem of multicollinearity. Therefore, another procedure was used to determine if this problem existed and how to deal with it.

The previous SAS procedures were used to get a general idea of the what parameters to further study, to actually start building the model, another SAS procedure (PROC REG) was used. The first PROC REG that was run included all five of the variables. The first run used the repair costs as the dependent variable and the monthly MTBF, the cumula-

Table IV

Regression Models for Dependent Variable Equal to Repair Costs

NUMBER IN MODEL	R-SQUARE	VARIABLES IN MODEL
1	0.00003432	MON
1	0.00345577	CUM
1	0.02462241	WAR
1	0.87281681	AQC
2	0.00527844	MON CUM
2	0.02511502	WAR CUM
2	0.02914599	WAR MON
2	0.87281757	WAR AQC
2	0.87320067	CUM AQC
2	0.87402353	MON AQC
3	0.03300094	WAR MON CUM
3	0.87321414	WAR CUM AQC
3	0.87402673	MON CUM AQC
3	0.87418141	WAR MON AQC
4	0.87418719	WAR MON CUM AQC

Table V

Regression Models for Dependent Variable Equal to Warranty Costs

NUMBER IN MODEL	R-SQUARE	VARIABLES IN MODEL
1	0.02462241	REP
1	0.02852153	AQC
1	0.05627723	CUM
1	0.13117994	MON
2	0.02852739	REP AQC
2	0.07678843	REP CUM
2	0.07863488	CUM AQC
2	0.13443557	MON CUM
2	0.15607098	MON AQC
2	0.15647362	REP MON
3	0.07873274	REP CUM AQC
3	0.15712866	REP MON AQC
3	0.15806700	MON CUM AQC
3	0.15855852	REP MON CUM
4	0.15913941	REP MON CUM AQC

tive MTBF, the acquisition costs, and the warranty costs as the independent variables. Part of this run is shown in Table VI and shows an R squared value of .8742. This means that the model consisting of these four independent variables can explain 87.4 percent of the variation in the dependent variable repair costs. The first item to be examined is the F statistic. In this case, the F value is 281.407 with a probability of .0001. As was previously stated the alpha value for this research is .01, and since the value .0001 is less than .01, the null hypothesis can be rejected. The null hypothesis referred to in this case states that all of the nonintercept beta coefficients are equal to each other and are equal to zero. The alternate hypothesis is that at least one of the beta coefficients is not equal to zero. When this null is rejected it implies that the alternate hypothesis is true. To test which of the coefficients are significantly different from zero the column showing the T probability must be examined. The null hypothesis for this t-test states that the beta coefficient for that particular independent variable equals zero given that all the independent variables are in the model. The alternate hypothesis states that the beta coeffecient does not equal zero, under these conditions. A two sided t-test was used with an alpha equal to .01. This means that any probability below .005 or greater than .995

Table VI

Regression Analysis for the Repair Costs with Four Independent Variables

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	4	6017109896	1504277474	281.407	0.0001
ERROR	162	865980976.66	5345561.58		
C TOTAL	166	6883090873			

ROOT MSE	2312.047	R-SQUARE	0.8742
DEP MEAN	2901.644	ADJ R-SQ	0.8711
C.V.	79.68059		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|
INTERCEP	1	-394.287	803.84038079	-0.491	0.6244
WAR	1	0.005353138	0.0117769	0.455	0.6500
MON	1	0.30232524	0.27009103	1.119	0.2646
CUM	1	0.004017319	0.04654442	0.086	0.9313
AQC	1	0.16659725	0.005062053	32.911	0.0001

VARIABLE	DF	STANDARDIZED ESTIMATE	TOLERANCE
INTERCEP	1	0	.
WAR	1	0.01380523	0.84193300
MON	1	0.03822062	0.66610534
CUM	1	0.002829195	0.72280541
AQC	1	0.93333313	0.96564791

would result in a rejection of the null. When this null is rejected it means that that particular beta value is significantly different from zero. In the case of the repair cost model the only value that can be said to be other than zero is the beta coeffecient associated with the acquisition costs. Table VI also shows the tolerances of each of the independent variables. The tolerance is defined as one minus R squared, where the R refers to the degree of correlation between each of the independent variables. Because it is desirable to have a low amount if correlation between the independent variables, a high tolerance is desired. Table VI shows that the lowest of the four tolerances is .666, therefore there is not a problem with multicollinearity. This explains the first regression analysis with the repair costs as the dependent variable.

After the first regression analysis, the model included one dependent variable (repair costs) and one independent variable (acquisition costs). This new model was then run through the SAS process again. The results of this regression are shown in Table VII. This Table shows an F value of 1132.341 with a probability of .0001. The null hypothesis for this F test is rejected, which says that the beta coefficients for the independent variable is not equal to zero. This statement is reinforced by the T

Table VII

Regression Analysis for the Repair Costs with One Independent Variable

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	1	6007677402	6007677402	1132.341	0.0001
ERROR	165	875413470.58	5305536.19		
C TOTAL	166	6883090873			

ROOT MSE	2303.375	R-SQUARE	0.8728
DEP MEAN	2901.644	ADJ R-SQ	0.8720
C.V.	79.38172		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|
INTERCEP	1	258.50897407	194.78023410	1.327	0.1863
AQC	1	0.16676031	0.004955689	33.650	0.0001

VARIABLE	DF	STANDARDIZED ESTIMATE	TOLERANCE
INTERCEP	1	0	.
AQC	1	0.93424665	1.00000000

value of 33.65 with a probability of .0001. This Table also shows that the y intercept is 258.51 and the beta coefficient for the acquisition costs is .1667. Therefore, the equation for the model is:

$$\text{Repair Costs} = .1667(\text{Acquisition Costs}) + 258.51 \qquad (1)$$

This model must now be checked for aptness. Aptness checks are performed to check the assumptions of homoscedasticity and normality of the random errors. Aptness checks are done by examining three graphs: a normal probability plot, a plot of standardized residuals vs predicted values for the dependent variable, and a plot of the predicted dependent variable value vs dependent variable values. A residual is the difference between the observed repair cost and the predicted repair cost. If the difference is small, then much of the variability seen in the repair costs can be connected to the independent variable. If the residual is large then there is some inherent variability in the repair costs (6:461).

The graph of the normal probability plot should evidence an appropriate linear relationship between the standardized residuals and the Z values, if the data is from a normal population. This plot is used to check normality. The residuals were obtained from SAS and a sample of the SAS output containing the residuals is shown in

Appendix D. Figure 1 shows this graph for the model in equation 1. The Z values were obtained from Powerpack using the program shown in Appendix C. The plot of this data does not produce a straight line. This means that the assumption of normality may not be a valid assumption for this model. The second plot is of the standardized residuals vs the predicted repair costs and is used to check homoscedasticity. This should show an even distribution around the zero line. Figure 2 shows that there is a slight problem in that there appears to be some outliers which cause the distribution not to be very even. Figure 3 shows this plot minus the last twelve observations, and it appears to have slightly improved the aptness. Figure 4 shows the predicted repair costs vs the actual repair costs. This Figure also has the last twelve observations removed, and it also seems to indicate the homoscedasticity problem is not severe. Therefore, the homoscedasticity assumption is not grossly violated and was assumed to be valid.

While the homoscedasticity assumption is declared valid, the normality assumption is still invalid. Transformations were performed on the indepedent variable, acquisition costs, to improve the model aptness. A transformation is the process of performing a mathematical operation on the independent variables that does not change

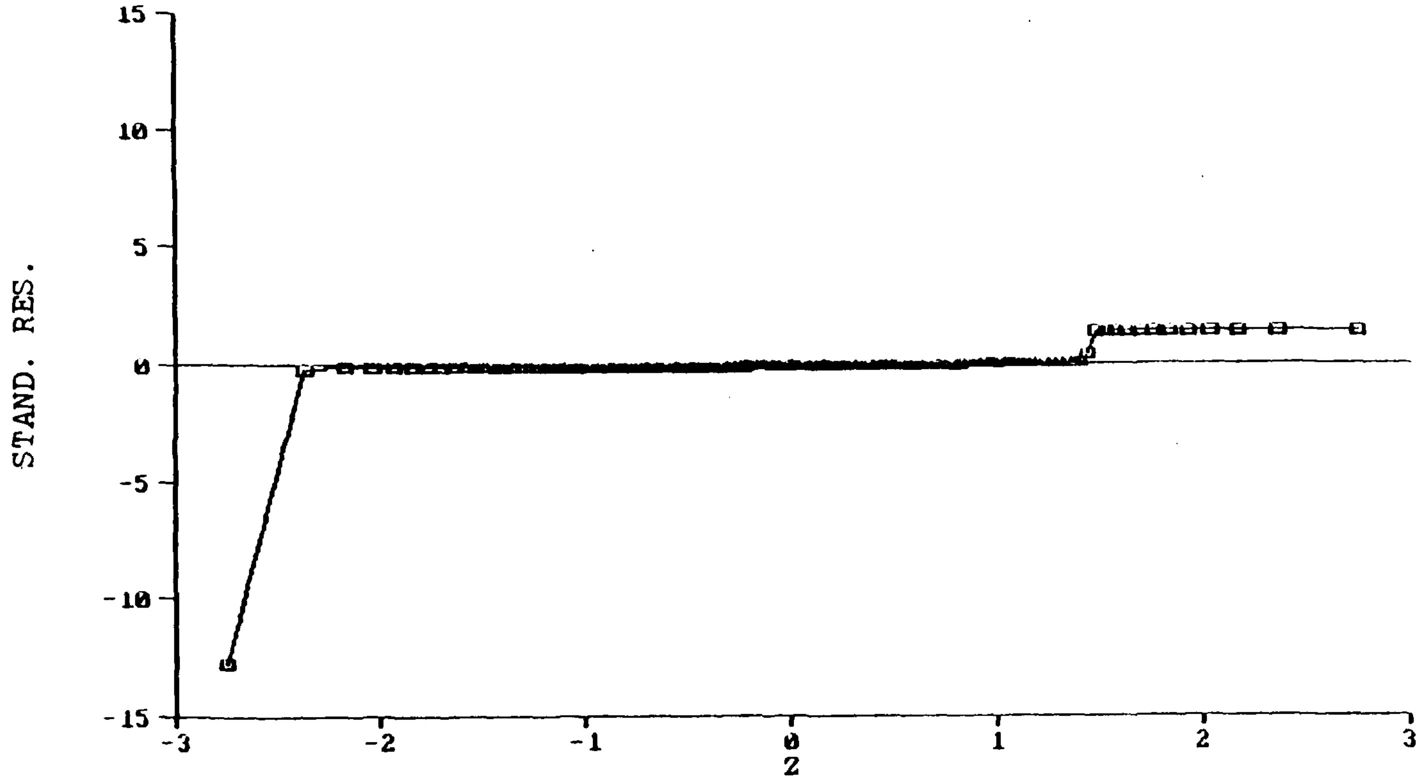

Figure 1. Normality Aptness Check #1 for Model One

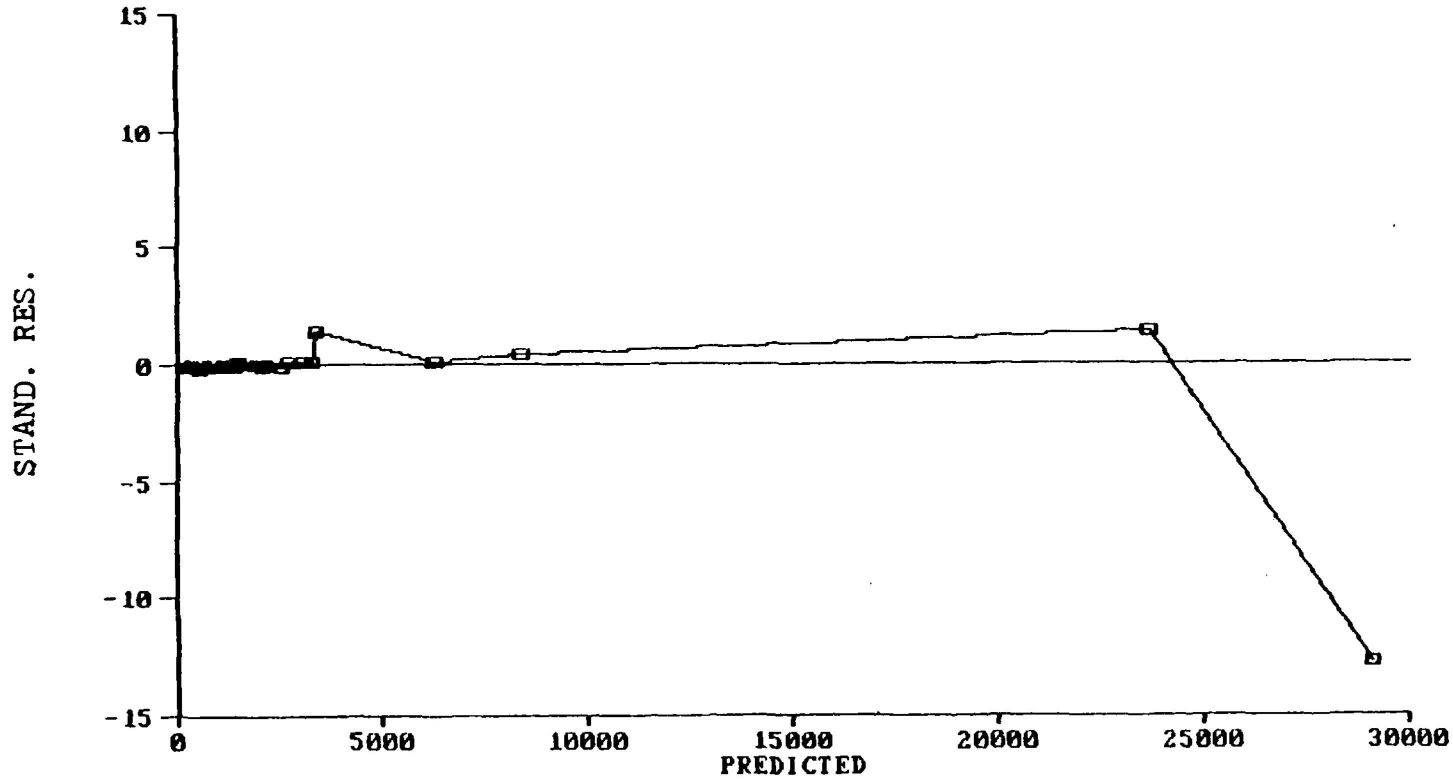

Figure 2. Aptness Check #2

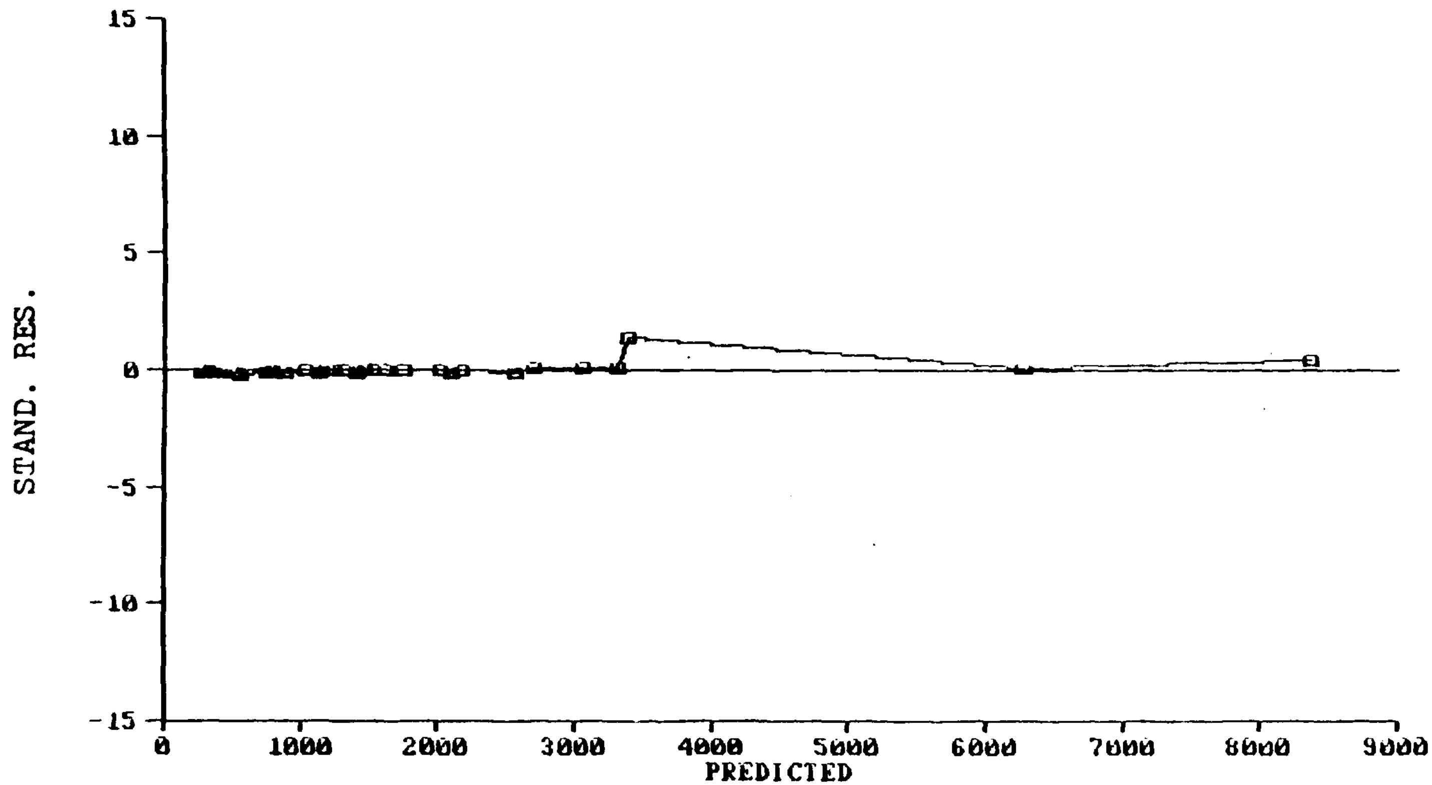

Figure 3. Aptness Check #2 Minus Last Twelve Observations

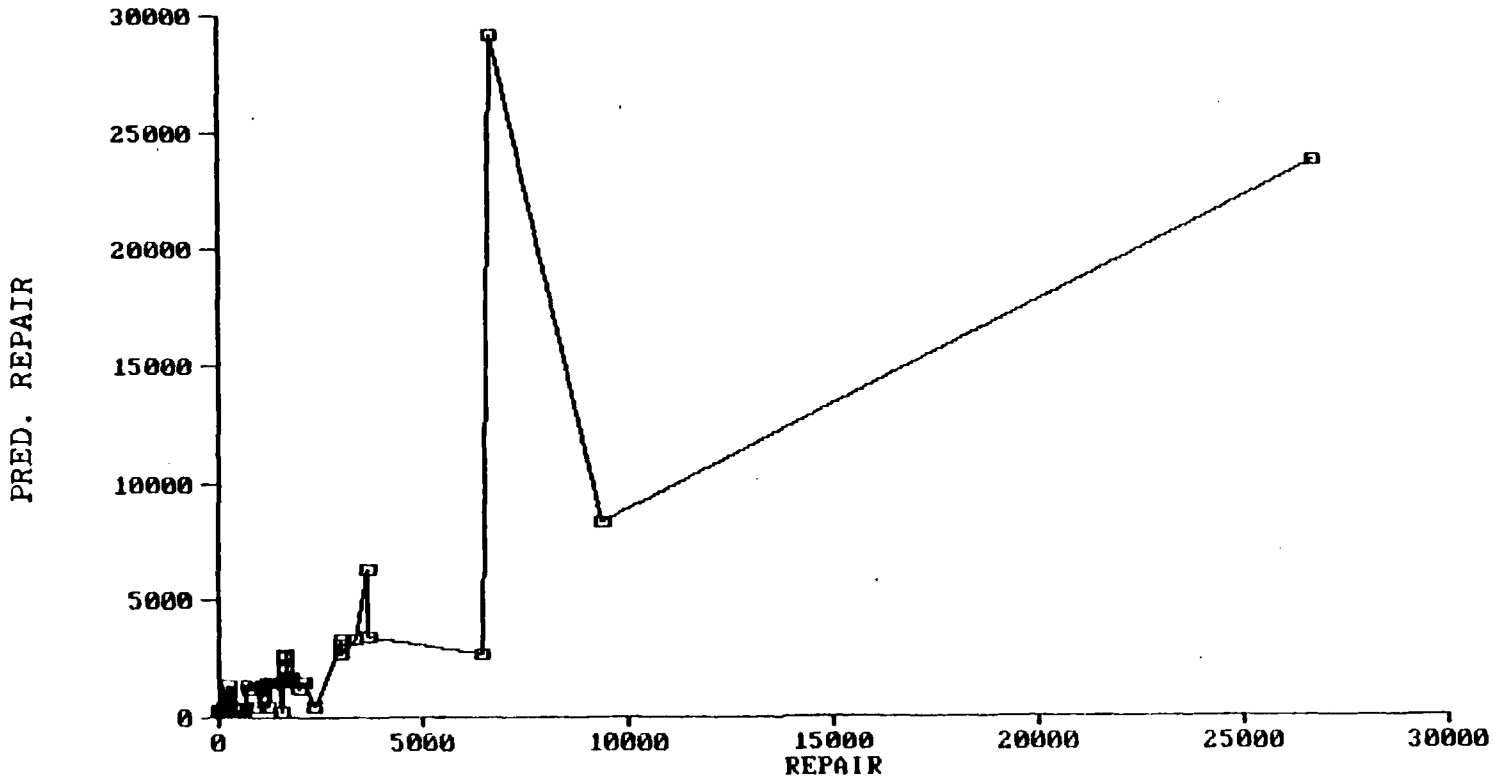

Figure 4. Atpness Check #3

the base value. This means that addition, subtraction, multiplication or division can not be used. Table VIII shows a list of the transformations performed.

Table VIII
Transformations Performed on Acquisition Costs

1. Cosine
2. Sine
3. Tangent
4. Log
5. Natural Log
6. Inverse
7. Squared
8. Square Root

Each of these operations was done to the independent variable and then the entire SAS process of checking the F and T statistics was redone for each of the transformations. Table IX shows the R squared values for each of these transformations and Appendix E has the values for the transformations. Table IX shows that the two best candidates, for continued research, are the square root of the acqusition costs or the acquisition costs squared. Figures 5 and 6 show the standardized residual vs Z plots for the square root and the squared values respectively. The plots are very similar, therefore the variable which could explain the larger portion of the variance in the dependent variable was chosen. This was the square root of the ac-

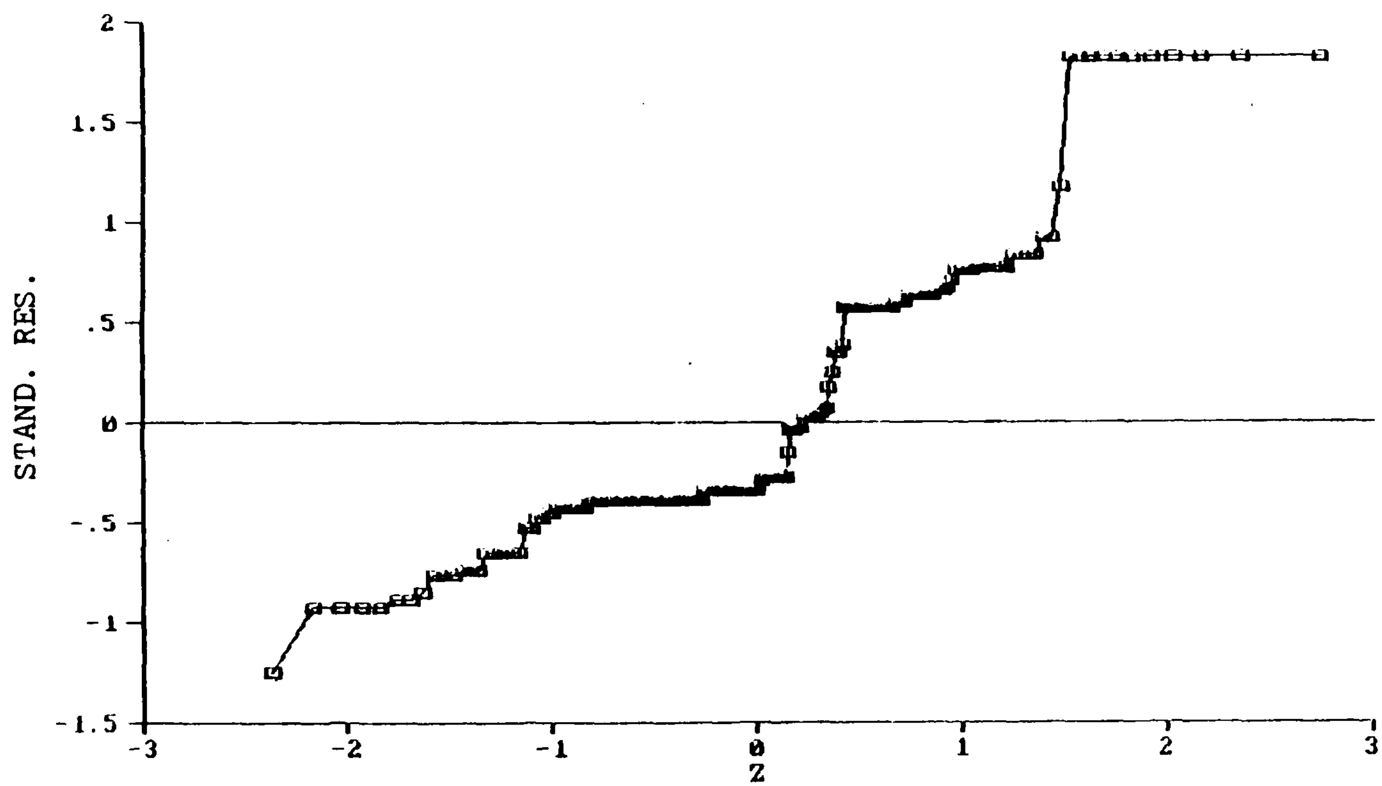

Figure 5. Aptness Check for the Square Root Transformation

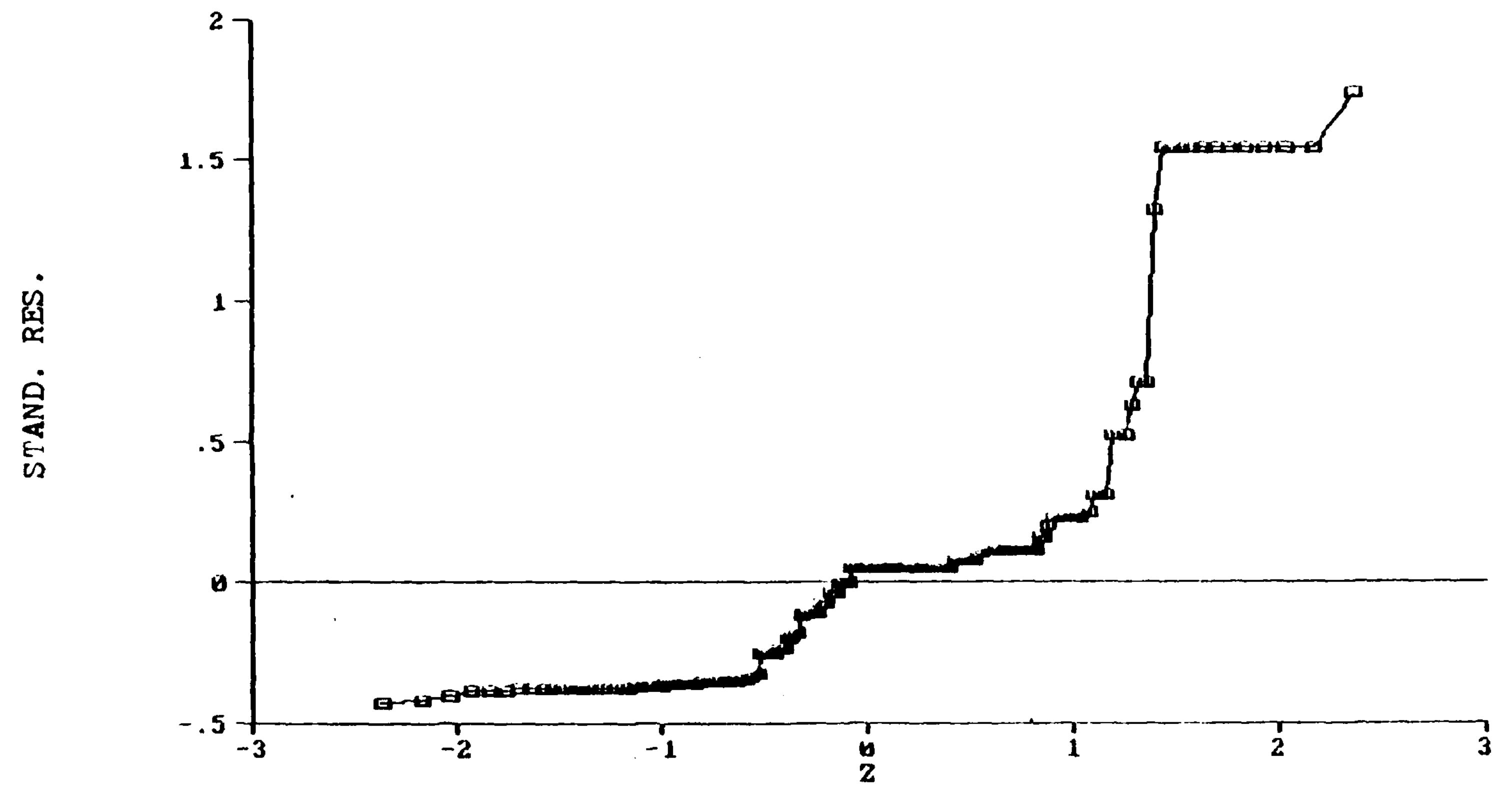

Figure 6. Aptness Check for the Squared Transformation

quisition costs (see Figure 4). From Table IX the equation for the model is now:

$$\text{Repair Costs} = 68.1147(\text{Sq Rt Acq. Costs}) - 3321.19 \qquad (2)$$

The other identified dependent variable was the cost of the warranty. The PROC REG procedure was also used to study this dependent variable. Table X shows part of the SAS run. This Table shows an R squared value of .1591. This says that with all four independent variables only 15.91 percent in the variance of the warranty costs can be explained. This is a very low R squared value, therefore, no further analysis was done on this dependent variable model.

Table IX

Summary ANOVA for the Transformations

Transformation	F value	F prob	R squared	T value	T prob	Estimated Intercept	Estimated Transform.
sine	28.119	.0001	.1456	5.303	.0001	3569.42	3876
cosine	3.779	.0536	.0224	1.944	.0536	2841.8	1273.9
tangent	.765	.3829	.0046	.875	.3829	2957.88	49.75
log	157.11	.0001	.4846	12.53	.0001	-22124.9	6838.94
natural log	157.11	.0001	.4878	12.53	.0001	-22124.9	2970.12
inverse	3.55	.0614	.0211	-1.884	.0614	3243.04	-520218
square root	897.23	.0001	.8447	29.95	.0001	-3321.19	68.11
square	661.86	.0001	.8005	25.727	.0001	1244.35	.000001

Summary

Chapter IV has followed the steps taken to answer the investigative and the research questions stated in Chapter I. These steps followed the methodology developed in Chapter III. In the final chapter, conclusions and recommendations for further study will be presented.

Table X

Regression Analysis for Warranty Costs
with Four Independent Variables

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	4	7285035684	1821258921	7.665	0.0001
ERROR	162	38492660273	237609014.03		
C TOTAL	166	45777695956			

ROOT MSE	15414.57	R-SQUARE	0.1591
DEP MEAN	55367.55	ADJ R-SQ	0.1384
C.V.	27.84044		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|
INTERCEP	1	62560.72519	2145.87081	29.154	0.0001
REP	1	0.23794579	0.52348050	0.455	0.6500
MON	1	-6.79718	1.72697922	-3.936	0.0001
CUM	1	-0.192916	0.30995149	-0.622	0.5345
AQC	1	0.03129011	0.0935324	0.335	0.7384

VARIABLE	DF	STANDARDIZED ESTIMATE	TOLERANCE
INTERCEP	1	0	.
REP	1	0.09226624	0.12597327
MON	1	-0.333209	0.72420008
CUM	1	-0.0526818	0.72450054
AQC	1	0.06797367	0.12572381

V. Conclusions and Recommendations

Overview

The purpose of this chapter is to draw conclusions about the research findings, and to make recommendations for further research.

Conclusions

Three primary conclusions resulted from this research. The first conclusion deals with the tracking of warranty related information. The experts consulted in the second research stage (see Chapter four) agreed that the Deputy for Propulsion had the best and most current warranty coverage and tracking system. However, when this researcher tried to collect the data associated with the F100-220 engine program, many problems arose. The primary problem deals with the costs associated with the warranty repairs. The Air Force pays for the warranty coverage it recieves on the F100-220 engine in a lump sum. This cost is a line number in the contract. This method works well for the first year or two, depending on the length of time it takes to repair the system under warranty. However, in the years after this initial period, the Air Force should be able to look at the Mean Time to Repair (MTTR), the Mean Time Between Failures (MTBF), and the actual costs associated with

the repairs. The repair costs are the costs to repair the warranty claims for the first year or two. Using this data the Air Force should be able to renegotiate the warranty costs for the later years.

This is not the case at the present time. Pratt and Whitney (P&W), the prime contractor for the F100-220 engine, charges the Government a flat fixed fee for the warranty and the Air Force recieves no actual cost data on the warranty repairs, nor does the Air Force see any reason to recieve this data. This researcher was informed by more than one US Air Force Office that not only would the tracking of this data require more manpower than was possible to obtain, but that no one in the Air Force needed to know the actual costs of the repairs. There was no need to know these costs because all of the repair costs are at P&W's expense, in accordance with the contract. However, a look at the data reveals the following discrepency. The Air Force paid in excess of 124 million dollars for the warranty in fiscal years 1986 and 1987. Using the equation produced by the analysis in chapter four the cost of the repairs, for this same time period, is 443,000 dollars. Using the Air Force Logistic Command data for repair costs, the price of repairs during this two year period is 417,000 dollars. Using the most conservative of the two estimates, it appears that the Government is paying the contractor

more than forty-three times the amount it actually costs to repair the items.

There may be three explanations for this apparent disconnect. The first is that a large portion of the failures that were repaired under the warranty clause were not included in the INFOCEN data base. This possibility was investigated, and this explaination is not likely. The person in charge of the data base, reported that this data base includes every service report that was submitted against the F100-220 engine. The field was submitting every failure as a warranty claim and letting the review board make the decision not to include the failure as a warranty claim. The second explaination might be that there is a number of items which are included in the price of the warranty and add value but cannot be measured monetarily. These items may include monitoring of the subcontractors and technical expertise. The third explanation is the most optimistic of the three. The warranty may actually serve to incentivize the contractor into improving the product before the product goes to the field. In this case, the difference between what the Government pays and what the repairs cost becomes profit. If this is true, the Air Force benefits from a better system than it contracted for and the company benefits from more profits and a better reputation.

The second conclusion deals with the two dependent variables identified in the fourth chapter: repair costs and warranty costs. This research attempted to produce models for both of these variables. In the case of the warranty costs, the variables identified in Table II are not enough. These independent variables could only explain about sixteen percent of the variance in the warranty costs. This percentage is too low to build an effective model. This low percentage means that there is some other independent variable or variables, not included in this research, which have influence on warranty costs. In the case of the repair costs, the regression analysis produced two models. The first model explained about 87 percent of the variation of the repair costs but, when this model was checked for aptness the model failed. In an attempt to improve the aptness several transformations were performed. The results of the regression analysis on the transformed data produced another model which could explain about 92 percent of the variation in the repair costs. This model used the square of the acquisition costs and was more apt. However, one of the fundamental assumptions of the regression analysis is that the data is from a normal distribution. There is a simple check for normality in Devore (6:574). The null hypothesis for this test is that the population is normally distributed and the alternate

hypothesis is that the distribution is not normal. When the data for this research was analyzed, the null was rejected. This means that the research data cannot be modeled by a normal curve or the equations that go with the normal distribution.

The final conclusion ties the models for the dependent variables back to the concept of component breakout. It is important to note that while the models developed by this research may not be valid, the research results are valid. The concept of component breakout is to take the highest cost items in a system and compete them. Most of the time, this results in the Air Force going directly to the part manufacturer. The government goes to the manufacturer because many times the prime contractor adds cost to the price of an item for things such as overhead and profit. These costs may be avoided by component breakout. Therefore, the more the government knows about costing the better the cost decisions made within the government will be. This research focused on two parts of cost -- the repair costs and the warranty costs. Both of these costs are logistic costs and logistic costs are a large portion of the defense budget. This research clearly showed that there was a relationship between repair costs and acqusition costs; therefore, if component breakout can reduce the acqusition costs, then the repair costs will go down. Air

Force managers need to be more informed about the logistics costs of a system before making a component breakout decision.

Recommendations

There are five main recommendations resulting from this research. The first deals with the data and the collection of the data. The Air Force should investigate the costs associated with collecting the actual warranty repair costs when a warranty is used. There may even be a data item which exists which could be used.

The second recommendation deals with the identified variables. These variables (Table II) did not explain enough. In the case of warranty costs, some maintenence variables should be included. These variables could include Mean Time To Repair (MTTR), fault isolation times, depot costs, etc. Another factor which was not emphasized in this research which would have a large bearing on a breakout decision is the secondary failures. These are failures which directly result from the failure of another item. With further research and the inclusion of maintainability factors a relationship may be found between acquisition costs and warranty costs. With this direct relationship, the link between component breakout and warranty costs will be complete. If acquisition costs can be decreased by breakout, the warranty cost will decrease

also. Then all that remains is to maintain the same warranty coverage.

The acqusition costs could also be investigated further. This would allow a more direct link between component breakout and the costs associated with it. To further investigate acquisition costs, other independent variables, such as overhead and profit margin, would have to be included.

Another recommendation would be to fit this data to a different statistical distribution. As was stated previously, the normal distribution was not valid in this case. A better distribution might be the log normal curve. This disribution does not have any negative numbers, which is a reasonable assumption when dealing with costs. The log-normal recognizes that there will be a few low costs and a few high costs but a large number of average costs. The costs discussed in this research could also be tied to arrival times and repair times, which further lends credibility to the idea of a log-normal distribution. Another model would have to be built using the new distribution.

The final recommendation would be to try this same analysis in a different program office. Perhaps some of the data collection problems were associated with the Deputy of Propulsion. Another program office with a more

active component breakout program would be interesting also. An office with more breakout data coupled with the identification of a few more variables could result in a useful decision support system for managers making component breakout decisions.

Summary

The research performed produced some interesting results. There was no valid model produced but the research proves that there is more to warranty costs than reliability considerations. This means that if the Air Force is pricing the warranties on how often the item breaks, instead of looking at how long it takes to fix the problem, the warranty price may not have any basis. The research also proved that more research should be done on the underlying factors to warranty costs. If these factors can be better understood and modeled then managers may not have to lose so much in the way of lost warranty coverage, when a part is broken out. A better understanding of warranty costs may also serve to close the considerable gap that exists between what the Air Force the repairs to cost and what the contractor is charging for the warranty.

This chapter also gives some recommendations for further research which may improve the understanding of the

relationship between component breakout and warranty coverage.

Appendix A: F100-220 Engine Part Data

NO.	DISCOVERED DATE	PART	REP. COST	WAR. COST
1	5 JUN 86	PS2 PROBE	1452.13	67127.39
2	10 JUL 86	TT2 SENSOR	2990.71	67127.39
3	17 JUL 86	DEEC	1540.9	67127.39
4	5 AUG 86	TT2 SENSOR	2990.71	67127.39
5	5 AUG 86	MFC	26688	67127.39
6	6 AUG 86	MFC-MV/RES	707.44	67127.39
7	21 AUG 86	DEEC	1540.9	67127.39
8	1 SEP 86	A/I VALVE	1627.4	67127.39
9	18 SEP 86	A/I VALVE	1627.4	67127.39
10	2 OCT 86	PS2 PROBE	1452.13	67127.39
11	13 OCT 86	P&S CABLE	955.96	67127.39
12	14 OCT 86	PS2 PROBE	1452.13	67127.39
13	20 OCT 86	DEEC (BRD)	1633.78	67127.39
14	29 OCT 86	PS2 PROBE	1452.13	67127.39
15	30 OCT 86	PS2 PROBE	1452.13	67127.39
16	6 NOV 86	LOD	2111.5	67127.39
17	11 NOV 86	CIVV	2347.83	67127.39
18	14 NOV 86	RCVV ACT.	542.07	67127.39
19	25 NOV 86	ENPT	248.75	67127.39
20	30 NOV 86	EDU	3671.47	67127.39
21	5 DEC 86	PS2 PROBE	1452.13	67127.39
22	9 DEC 86	MFC	26688	67127.39
23	23 JAN 87	AFC	9370.23	67127.39
24	8 JAN 87	PS2 PROBE	1452.13	67127.39
25	16 JAN 87	DEEC	1540.9	67127.39
26	21 JAN 87	A/I VALVE	1627.4	67127.39
27	8 JAN 87	CABLE	928.81	67127.39
28	21 JAN 87	TUBE ASS.	100.1	67127.39
29	22 JAN 87	MFC	26688	67127.39
30	29 JAN 87	PS2 PROBE	1452.13	67127.39
31	2 FEB 87	DEEC	1540.9	67127.39
32	10 FEB 87	ENPT	248.75	67127.39
33	23 FEB 87	FTIT PROBE	189.08	67127.39
34	23 FEB 87	SPRAY MAN	1184.14	67127.39
35	25 FEB 87	STATOR GENERATOR	687.8	67127.39
36	23 FEB 87	PS2 PROBE	1452.13	67127.39
37	25 FEB 87	CABLE	955.96	67127.39
38	25 FEB 87	AFPC	1972.18	67127.39
39	5 MAR 87	PS2 PROBE	1452.13	67127.39
40	9 MAR 87	MAIN FUEL PUMP	3360.14	67127.39
41	16 MAR 87	PS2 PROBE	1452.13	67127.39

42	25 MAR 87	ENPT	248.75	67127.39
43	30 MAR 87	PS2 PROBE	1452.13	67127.39
44	2 APR 87	PS2 PROBE	1452.13	67127.39
45	3 APR 87	MFC	26688	67127.39
46	8 APR 87	PS2 PROBE	1452.13	67127.39
47	9 APR 87	PS2 PROBE	1452.13	67127.39
48	29 APR 87	DIV. SEAL	177.2	67127.39
49	30 APR 87	CABLE	955.96	67127.39
50	4 MAY 87	PS2 PROBE	1452.13	67127.39
51	6 MAY 87	RCVV ACT.	542.07	67127.39
52	6 MAY 87	RCVV ACT.	542.07	67127.39
53	6 MAY 87	EDU	3671.47	67127.39
54	6 MAY 87	MFC	26688	67127.39
55	7 MAY 87	PS2 PROBE	1452.13	67127.39
56	11 MAY 87	MFC	26688	67127.39
57	14 MAY 87	DEEC	1540.9	67127.39
58	15 MAY 87	PS2 PROBE	1452.13	67127.39
59	16 MAY 87	DIV. SEAL	177.2	67127.39
60	2 JUN 87	EDU **	1077.68	67127.39
61	2 JUN 87	DEEC	1540.9	67127.39
62	13 JUN 87	PS2 PROBE	1452.13	67127.39
63	17 JUN 87	EDU BRD.	1298.25	67127.39
64	21 JUN 87	PS2 PROBE	1452.13	67127.39
65	25 JUN 87	RCVV ACT.	542.07	67127.39
66	26 JUN 87	MOPT	266.23	67127.39
67	27 JUN 87	MOPT	266.23	67127.39
68	1 JUL 87	ENPT	232.1	67127.39
69	6 JUL 87	PS2 PROBE	1452.13	67127.39
70	10 JUL 87	ENPT	248.75	67127.39
71	10 JUL 87	A/I VAL.	1627.4	67127.39
72	10 JUL 87	EDU	1077.68	67127.39
73	10 JUL 87	MV/RES	304.75	67127.39
74	11 JUL 87	PS2 PROBE	1452.13	67127.39
75	15 JUL 87	INT. I/F BRD	1633.78	67127.39
76	15 JUL 87	ENPT	248.75	67127.39
77	16 JUL 87	A/I VAL.	1627.4	67127.39
78	20 JUL 87	CIVV	2347.83	67127.39
79	20 JUL 87	CIVV ACT.	330.66	67127.39
80	20 JUL 87	CIVV	2347.83	67127.39
81	22 JUL 87	PS2 PROBE	1452.13	67127.39
82	23 JUL 87	EDU BRD.	1298.25	67127.39
83	29 JUL 87	PLA/RES	747.15	67127.39
84	29 JUL 87	FLEX-SHAFT	268.76	67127.39
85	29 JUL 87	CIVV ACT.	330.66	67127.39
86	30 JUL 87	PS2 PROBE	1452.13	67127.39
87	1 AUG 87	PT6 TRANS.***	145.05	67127.39
88	5 AUG 87	MFC	26688	67127.39
89	10 AUG 87	PS2 PROBE	1452.13	67127.39
90	12 AUG 87	A/I VAL.	1627.4	67127.39
91	14 AUG 87	MFC	26688	67127.39

92	20 AUG 87	DIV SEAL	223.1	67127.39
93	24 AUG 87	DIV SEAL	223.1	67127.39
94	29 AUG 87	FLEX-SHAFT	213.87	67127.39
95	1 SEPT 87	MFC	26688	67127.39
96	1 SEPT 87	A/I VAL	1627.4	67127.39
97	2 SEPT 87	PS2 PROBE	1452.13	67127.39
98	2 SEPT 87	A/I VAL	1627.4	67127.39
99	5 SEPT 87	PS2 PROBE	1452.13	67127.39
100	8 SEPT 87	MFC	26688	67127.39
101	11 SEPT 87	EDU	1077.68	67127.39
102	12 SEPT 87	ENPT	248.75	67127.39
103	15 SEPT 87	FLAME HOLDER	2026.75	67127.39
104	16 SEPT 87	PT6 TRANSDUCER	599.04	67127.39
105	16 SEPT 87	EDU BRD.	1298.25	67127.39
106	16 SEPT 87	PS2 PROBE	1452.13	67127.39
107	16 SEPT 87	A/I VAL	1627.4	67127.39
108	16 SEPT 87	A/I VAL	1627.4	67127.39
109	16 SEPT 87	EDU BRD.	1192.69	67127.39
110	17 SEPT 87	INTER. BRD (DEEC)	1192.69	67127.39
111	23 SEPT 87	A/I VAL	1627.4	67127.39
112	1 OCT 87	PS2 PROBE	1452.13	32057.88
113	8 OCT 87	P&S CABLE	955.96	32057.88
114	14 OCT 87	DEEC	1540.9	32057.88
115	14 OCT 87	TT2 SENS****	2990.71	32057.88
116	14 OCT 87	A/I VAL	1627.4	32057.88
117	15 OCT 87	P6 PRESS SENS***	594.1	32057.88
118	15 OCT 87	CONVERTER BRD***	1786.02	32057.88
119	15 OCT 87	DIV. SEAL	177.2	32057.88
120	15 OCT 87	DIV. SEAL	177.2	32057.88
121	15 OCT 87	RCVV ACT.	542.07	32057.88
122	24 OCT 87	PS2 PROBE	1452.13	32057.88
123	26 OCT 87	FLAME HOLDER	2026.75	32057.88
124	26 OCT 87	DIV SEAL	177.2	32057.88
125	26 OCT 87	DIV SEAL	177.2	32057.88
126	29 OCT 87	ENPT	248.75	32057.88
127	3 NOV 87	MFC	26688	32057.88
128	4 NOV 87	FLAME HOLDER	2026.75	32057.88
129	10 NOV 87	CABLE	42.68	32057.88
130	12 NOV 87	DIV. SEAL	177.2	32057.88
131	13 NOV 87	DIV. SEAL	223.1	32057.88
132	16 NOV 87	PLA/RES	747.15	32057.88
133	19 NOV 87	FLAME HOLDER	2026.75	32057.88
134	22 NOV 87	PS2 PROBE	1452.13	32057.88
135	23 NOV 87	DIV. SEAL	223.1	32057.88
136	23 NOV 87	CABLE	955.96	32057.88
137	24 NOV 87	FTIT PROBE	189.08	32057.88
138	24 NOV 87	FTIT PROBE	189.08	32057.88
139	24 NOV 87	FTIT PROBE	189.08	32057.88
140	24 NOV 87	FTIT PROBE	189.08	32057.88
141	30 NOV 87	DIV. SEAL	146.25	32057.88

142	30 NOV 87	DIV. SEAL	146.25	32057.88
143	30 NOV 87	FLAMEHOLDER	2026.75	32057.88
144	1 DEC 87	DIV. SEAL	223.1	32057.88
145	2 DEC 87	LOD	2111.5	32057.88
146	7 DEC 87	FTIT SENS***	189.08	32057.88
147	8 DEC 87	A/I VAL	1627.4	32057.88
148	10 DEC 87	COUPLING	7	32057.88
149	17 DEC 87	EDU BRD.	1298.25	32057.88
150	19 DEC 87	A/I VAL	1627.4	32057.88
151	21 DEC 87	FLAMEHOLD	2026.75	32057.88
152	23 DEC 87	DIV SEAL	177.2	32057.88
153	28 DEC 87	DIV SEAL	177.2	32057.88
154	4 JAN 88	PT6 PRES****	599.04	32057.88
155	4 JAN 88	CONV. BRD	1786.02	32057.88
156	5 JAN 88	PS2 PROBE	1452.13	32057.88
157	6 JAN 88	DIV SEAL	223.1	32057.88
158	11 JAN 88	PS2 PROBE	236.72	32057.88
159	14 JAN 88	DIV SEAL	177.2	32057.88
160	14 JAN 88	DEEC	1540.9	32057.88
161	15 JAN 88	CENC	6445.19	32057.88
162	15 JAN 88	PS2 PROBE ***	236.72	32057.88
163	19 JAN 88	DIV SEAL	177.2	32057.88
164	22 JAN 88	DIV SEAL	177.2	32057.88
165	2 FEB 88	DIV SEAL	177.2	32057.88
166	3 FEB 88	DIV SEAL	177.2	32057.88
167	25 FEB 88	COMB CHAMBER	6632.78	32057.88

NO.	DISCOVERED DATE	PART	MONTHLY MTBF	CUM MTBF	PRICE
1	5 JUN 86	PS2 PROBE	205	205	7134.99
2	10 JUL 86	TT2 SENSOR	102.5	102.5	14675.64
3	17 JUL 86	DEEC	102.5	102.5	7631.8
4	5 AUG 86	TT2 SENSOR	102.5	102.5	14675.64
5	5 AUG 86	MFC	102.5	102.5	140449.22
6	6 AUG 86	MFC-MV/RES	102.5	102.5	3228.29
7	21 AUG 86	DEEC	102.5	102.5	173069.44
8	1 SEP 86	A/I VALVE	102.5	102.5	7293.73
9	18 SEP 86	A/I VALVE	102.5	102.5	7293.73
10	2 OCT 86	PS2 PROBE	108	106.2	7134.99
11	13 OCT 86	P&S CABLE	432	432	5309.9
12	14 OCT 86	PS2 PROBE	108	106.2	7134.99
13	20 OCT 86	DEEC (BRD)	432	212.3	8168.93
14	29 OCT 86	PS2 PROBE	108	106.2	7134.99
15	30 OCT 86	PS2 PROBE	108	106.2	7134.99
16	6 NOV 86	LOD	461	1098	11459.1
17	11 NOV 86	CIVV	461	1098	13803.21
18	14 NOV 86	RCVV ACT.	461	1098	3110.79
19	25 NOV 86	ENPT	461	1098	821.98
20	30 NOV 86	EDU	461	1098	18357.37
21	5 DEC 86	PS2 PROBE	901	333.2	7134.99
22	9 DEC 86	MFC	901	666.3	140449.22
23	23 JAN 87	AFC	797	2796	48673.68
24	8 JAN 87	PS2 PROBE	398.5	349.5	7134.99
25	16 JAN 87	DEEC	797	699	7631.8
26	21 JAN 87	A/I VALVE	797	932	7293.73
27	8 JAN 87	CABLE	797	1398	4644.05
28	21 JAN 87	TUBE ASS.	797	2796	46.01
29	22 JAN 87	MFC	797	699	140449.22
30	29 JAN 87	PS2 PROBE	398.5	349.4	7134.99
31	2 FEB 87	DEEC	917	742.6	7631.8
32	10 FEB 87	ENPT	917	1856.5	821.98
33	23 FEB 87	FTIT PROBE	917	3713	508.96
34	23 FEB 87	SPRAY MAN	917	3713	5920.74
35	25 FEB 87	STATOR GENERATOR	917	3713	3238.62
36	23 FEB 87	PS2 PROBE	917	412.6	7134.99
37	25 FEB 87	CABLE	917	1237.	5309.9
38	25 FEB 87	AFPC	917	3713	11037.43
39	5 MAR 87	PS2 PROBE	470.7	427.1	7134.99
40	9 MAR 87	MAIN FUEL PUMP	1412	5125	16800.72
41	16 MAR 87	PS2 PROBE	470.7	427.1	7134.99
42	25 MAR 87	ENPT	1412	1708.3	821.98
43	30 MAR 87	PS2 PROBE	470.7	427.1	7134.99
44	2 APR 87	PS2 PROBE	559.3	453.5	7134.99
45	3 APR 87	MFC	1678	1360	140449.22

46	8 APR 87	PS2 PROBE	559.3	453.5	7134.99
47	9 APR 87	PS2 PROBE	559.3	453.5	7134.99
48	29 APR 87	DIV. SEAL	1678	6803	886.02
49	30 APR 87	CABLE	1678	1700.8	5309.9
50	4 MAY 87	PS2 PROBE	601	478.1	7134.99
51	6 MAY 87	RCVV ACT.	901.5	2868.7	3110.79
52	6 MAY 87	RCVV ACT.	901.5	2868.7	3110.79
53	6 MAY 87	EDU	1803	4303	18357.37
54	6 MAY 87	MFC	901.5	1229.4	140449.22
55	7 MAY 87	PS2 PROBE	601	478.1	7134.99
56	11 MAY 87	MFC	901.5	1229.	140449.22
57	14 MAY 87	DEEC	1803	1434.3	7631.8
58	15 MAY 87	PS2 PROBE	601	478.1	7134.99
59	16 MAY 87	DIV. SEAL	1803	4303	886.02
60	2 JUN 87	EDU **	944.5	2623.8	5600.79
61	2 JUN 87	DEEC	1887	1499.3	7631.8
62	13 JUN 87	PS2 PROBE	944.5	524.8	7134.99
63	17 JUN 87	EDU BRD.	944.5	2623.8	6491.25
64	21 JUN 87	PS2 PROBE	944.5	524.8	7134.99
65	25 JUN 87	RCVV ACT.	1889	2623.8	3110.79
66	26 JUN 87	MOPT	944.5	5247.5	913.69
67	27 JUN 87	MOPT	944.5	5247.5	913.69
68	1 JUL 87	ENPT	801.3	2579.8	734.65
69	6 JUL 87	PS2 PROBE	601	537.4	7134.99
70	10 JUL 87	ENPT	801.3	2579.8	821.98
71	10 JUL 87	A/I VAL.	1202	2579.8	7293.73
72	10 JUL 87	EDU	1202	2149.8	5600.79
73	10 JUL 87	MV/RES	2404	1612.4	1523.78
74	11 JUL 87	PS2 PROBE	601	537.4	7134.99
75	15 JUL 87	INT. I/F BRD	2404	1612.4	8168.93
76	15 JUL 87	ENPT	801.3	2579.8	821.98
77	16 JUL 87	A/I VAL.	1202	2579.8	7293.73
78	20 JUL 87	CIVV	601	2579.8	13803.21
79	20 JUL 87	CIVV ACT.	601	2579.8	1653.31
80	20 JUL 87	CIVV	601	2579.8	13803.21
81	22 JUL 87	PS2 PROBE	601	537.4	7134.99
82	23 JUL 87	EDU BRD.	1202	2149.8	6491.25
83	29 JUL 87	PLA/RES	2404	12899	3735.76
84	29 JUL 87	FLEX-SHAFT	2404	12899	926.95
85	29 JUL 87	CIVV ACT.	601	2579.8	1653.31
86	30 JUL 87	PS2 PROBE	601	537.4	7134.99
87	1 AUG 87	PT6 TRANS.***	2158	15057	278
88	5 AUG 87	MFC	1079	1505.7	140449.22
89	10 AUG 87	PS2 PROBE	2158	602.3	7134.99
90	12 AUG 87	A/I VAL.	2158	2509.5	7293.73
91	14 AUG 87	MFC	1079	1505.7	140449.22
92	20 AUG 87	DIV SEAL	1079	3764.2	568.83
93	24 AUG 87	DIV SEAL	1079	3764.2	442.9
94	29 AUG 87	FLEX-SHAFT	2158	7528.5	639.02
95	1 SEPT 87	MFC	1191	1453.3	140449.22

96	1 SEPT 87	A/I VAL	476.4	1585.4	7293.73
97	2 SEPT 87	PS2 PROBE	794.3	622.8	7134.99
98	2 SEPT 87	A/I VAL	476.4	1585.4	7293.73
99	5 SEPT 87	PS2 PROBE	794.3	622.8	7134.99
100	8 SEPT 87	MFC	1191	1453.3	140449.22
101	11 SEPT 87	EDU	794.3	1937.8	5600.79
102	12 SEPT 87	ENPT	2382	2906.7	821.98
103	15 SEPT 87	FLAME HOLDER	2382	17440	10578.71
104	16 SEPT 87	PT6 TRANSDUCER	2382	8720	3418.84
105	16 SEPT 87	EDU BRD.	794.3	1937.8	6491.25
106	16 SEPT 87	PS2 PROBE	794.3	7622.8	7134.99
107	16 SEPT 87	A/I VAL	476.4	1585.4	7293.73
108	16 SEPT 87	A/I VAL	476.4	1585.4	7293.73
109	16 SEPT 87	EDU BRD.	794.3	1937.8	6901
110	17 SEPT 87	INTER. BRD (DEEC)	2383	1937.8	6901
111	23 SEPT 87	A/I VAL	476.6	1585.4	7293.73
112	1 OCT 87	PS2 PROBE	1597	687.8	7134.99
113	8 OCT 87	P&S CABLE	3194	4126.8	5309.9
114	14 OCT 87	DEEC	1597	1875.8	7631.8
115	14 OCT 87	TT2 SENS****	3194	6878	14675.64
116	14 OCT 87	A/I VAL	3194	1719.5	7293.73
117	15 OCT 87	P6 PRESS SENS***	3194	6878	2970.52
118	15 OCT 87	CONVERTER BRD***	1597	1875.8	8930.1
119	15 OCT 87	DIV. SEAL	798.5	1587.2	886.02
120	15 OCT 87	DIV. SEAL	798.5	1587.2	886.02
121	15 OCT 87	RCVV ACT.	3194	4126.8	3110.79
122	24 OCT 87	PS2 PROBE	1597	687.8	7134.99
123	26 OCT 87	FLAME HOLDER	3194	10317	10578.71
124	26 OCT 87	DIV SEAL	798.5	1587.2	886.02
125	26 OCT 87	DIV SEAL	798.5	1587.2	886.02
126	29 OCT 87	ENPT	3194	2947.7	821.98
127	3 NOV 87	MFC	2811	1803.5	140449.22
128	4 NOV 87	FLAME HOLDER	937	4689	10578.71
129	10 NOV 87	CABLE	1405.5	3349.3	229.38
130	12 NOV 87	DIV. SEAL	562.2	1302.5	886.02
131	13 NOV 87	DIV. SEAL	562.2	1302.5	568.83
132	16 NOV 87	PLA/RES	2811	11722.5	3735.76
133	19 NOV 87	FLAME HOLDER	937	4689	10578.71
134	22 NOV 87	PS2 PROBE	2811	756.3	7134.99
135	23 NOV 87	DIV. SEAL	562.2	1302.5	568.83
136	23 NOV 87	CABLE	1405.5	3349.3	5309.9
137	24 NOV 87	FTIT PROBE	702.8	5861.2	508.96
138	24 NOV 87	FTIT PROBE	702.8	5861.2	508.96
139	24 NOV 87	FTIT PROBE	702.8	5861.2	508.96
140	24 NOV 87	FTIT PROBE	702.8	5861.2	508.96
141	30 NOV 87	DIV. SEAL	562.2	1302.5	389.34
142	30 NOV 87	DIV. SEAL	562.2	1302.5	389.34
143	30 NOV 87	FLAMEHOLDER	937	4689	10578.71
144	1 DEC 87	DIV. SEAL	917.3	1247.5	442.9
145	2 DEC 87	LOD	2752	13098.5	11459.1

146	7	DEC	87	FTIT SENS***	2752	5239.4	508.96
147	8	DEC	87	A/I VAL	1376	1871.2	7293.73
148	10	DEC	87	COUPLING	2752	26197	1789.78
149	17	DEC	87	EDU BRD.	2752	2619.7	6491.25
150	19	DEC	87	A/I VAL	1376	1871.2	7293.73
151	21	DEC	87	FLAMEHOLD	2752	4366.2	10578.71
152	23	DEC	87	DIV SEAL	917.3	1247.5	886.02
153	28	DEC	87	DIV SEAL	917.3	1247.5	886.02
154	4	JAN	88	PT6 PRES****	2389	7146.5	3418.84
155	4	JAN	88	CONV. BRD	1194.5	2198.9	8930.1
156	5	JAN	88	PS2 PROBE	796.3	840.8	7134.99
157	6	JAN	88	DIV SEAL	597.2	1143.4	568.83
158	11	JAN	88	PS2 PROBE	796.3	840.8	758.9
159	14	JAN	88	DIV SEAL	597.2	1143.4	886.02
160	14	JAN	88	DEEC	1194.5	2198.9	7631.8
161	15	JAN	88	CENC	2389	28586	36092.43
162	15	JAN	88	PS2 PROBE ***	796.3	840.8	758.9
163	19	JAN	88	DIV SEAL	597.2	1143.4	886.02
164	22	JAN	88	DIV SEAL	597.2	1143.4	886.02
165	2	FEB	88	DIV SEAL	1152.5	1144.1	886.02
166	3	FEB	88	DIV SEAL	1152.5	1144.1	886.02
167	25	FEB	88	COMB CHAMBER	2305	30891	18769.33

NO.	DISCOVERED DATE	PART	R.CONT #	AGENCY	ITEM #	REPORT #	GFE
1	5 JUN 86	PS2 PROBE	234	NAVPRO	17	95	1
2	10 JUL 86	TT2 SENSOR	320	NAVPRO	24	22	1
3	17 JUL 86	DEEC	331	NAVPRO	25	28	1
4	5 AUG 86	TT2 SENSOR	352	NAVPRO	29	21	1
5	5 AUG 86	MFC	227	33TFW		26	1
6	6 AUG 86	MFC-MV/RES	357	NAVPRO	27	15	1
7	21 AUG 86	DEEC	243	33TFW	44	30	
8	1 SEP 86	A/I VALVE	242	33TFW	41	183	
9	18 SEP 86	A/I VALVE	433	NAVPRO	2	185	1
10	2 OCT 86	PS2 PROBE	272	33TFW	54	88	
11	13 OCT 86	P&S CABLE	1	SA-ALC	61	127	
12	14 OCT 86	PS2 PROBE	283	33TFW	53	90	
13	20 OCT 86	DEEC (BRD)	287	33TFW	51	37&42	
14	29 OCT 86	PS2 PROBE	293	33TFW	58	91	
15	30 OCT 86	PS2 PROBE	500	NAVPRO	60	89	1
16	6 NOV 86	LOD	306	33TFW	171	73	
17	11 NOV 86	CIVV	307	33TFW	65	68	
18	14 NOV 86	RCVV ACT.	308	33TFW	63	60	
19	25 NOV 86	ENPT	315	33TFW	70	174	
20	30 NOV 86	EDU	318	33TFW	69	48	
21	5 DEC 86	PS2 PROBE	569	NAVPRO	86	93	1
22	9 DEC 86	MFC	330	33TFW	73	2	
23	23 JAN 87	AFC	35	NAVPRO	80	25	1
24	8 JAN 87	PS2 PROBE	6	33TFW	76	108	
25	16 JAN 87	DEEC	28	NAVPRO	95	31	1
26	21 JAN 87	A/I VALVE	20	33TFW	85	189	
27	8 JAN 87	CABLE	16	33TFW	90	130	
28	21 JAN 87	TUBE ASS.	21	33TFW	92	125	
29	22 JAN 87	MFC	26	33TFW	107	10	
30	29 JAN 87	PS2 PROBE	31	33TFW	91	103	
31	2 FEB 87	DEEC	266	33TFW	205	32	
32	10 FEB 87	ENPT	83	NAVPRO	102	173	1
33	23 FEB 87	FTIT PROBE	105	NAVPRO	108	86	1
34	23 FEB 87	SPRAY MAN	51	33TFW	111	137	
35	25 FEB 87	STATOR GENERATOR	52	33TFW	114	135&201	
36	23 FEB 87	PS2 PROBE	62	33TFW	116	94	
37	25 FEB 87	CABLE	53	33TFW	112	128	
38	25 FEB 87	AFPC	63	33TFW	115	27	
39	5 MAR 87	PS2 PROBE	69	33TFW	121	101	
40	9 MAR 87	MAIN FUEL PUMP	73	33TFW	129	71	
41	16 MAR 87	PS2 PROBE	78	33TFW	131	105	
42	25 MAR 87	ENPT	183	NAVPRO	128	172	1
43	30 MAR 87	PS2 PROBE	79	33TFW	130	110	
44	2 APR 87	PS2 PROBE	195	NAVPRO	133	92	1

45	3 APR 87	MFC	200	NAVPRO	139	12	1
46	8 APR 87	PS2 PROBE	113	33TFW	141	104	
47	9 APR 87	PS2 PROBE	110	33TFW	142	106&107	
48	29 APR 87	DIV. SEAL	121	33TFW	154	151	
49	30 APR 87	CABLE	117	33TFW	145	132	
50	4 MAY 87	PS2 PROBE	122	33TFW	148	109	
51	6 MAY 87	RCVV ACT.	131	33TFW	153	59	
52	6 MAY 87	RCVV ACT.	130	33TFW	147	64	
53	6 MAY 87	EDU	125	33TFW	150	49	
54	6 MAY 87	MFC	245	NAVPRO	146	13	1
55	7 MAY 87	PS2 PROBE	132	33TFW	149	120	
56	11 MAY 87	MFC	250	NAVPRO	156	11	1
57	14 MAY 87	DEEC	140	33TFW	158	36	
58	15 MAY 87	PS2 PROBE	142	33TFW	161	96	
59	16 MAY 87	DIV. SEAL	145	33TFW	162	156	
60	2 JUN 87	EDU **	164	33TFW	167	131	
61	2 JUN 87	DEEC	261	NAVPRO	166	35	1
62	13 JUN 87	PS2 PROBE	246	33TFW	193	121	
63	17 JUN 87	EDU BRD.	205	33TFW	177	52	
64	21 JUN 87	PS2 PROBE	255	33TFW	192	118	
65	25 JUN 87	RCVV ACT.	306	NAVPRO	176	62&63	1
66	26 JUN 87	MOPT	642	DET 27	215	202	1
67	27 JUN 87	MOPT	695	DET 27	333	203	
68	1 JUL 87	ENPT	647	DET 27	214	179	1
69	6 JUL 87	PS2 PROBE	238	33TFW	188	124	
70	10 JUL 87	ENPT	331	NAVPRO	184	176	1
71	10 JUL 87	A/I VAL.	330	NAVPRO	183	190	1
72	10 JUL 87	EDU	334	NAVPRO	186	51	1
73	10 JUL 87	MV/RES	329	NAVPRO	185	26	1
74	11 JUL 87	PS2 PROBE	248	33TFW	191	119	
75	15 JUL 87	INT. I/F BRD	265	33TFW	204	41	
76	15 JUL 87	ENPT	250	33TFW	197	175	
77	16 JUL 87	A/I VAL.	337	NAVPRO	190	191	1
78	20 JUL 87	CIVV	257	33TFW	198	70	
79	20 JUL 87	CIVV ACT.	258	33TFW	196	67	
80	20 JUL 87	CIVV	259	33TFW	195	69	
81	22 JUL 87	PS2 PROBE	6	944TFG	216	114	
82	23 JUL 87	EDU BRD.	272	33TFW	207	54	
83	29 JUL 87	PLA/RES	286	33TFW	218	18	
84	29 JUL 87	FLEX-SHAFT	2	DET 4	220	199	
85	29 JUL 87	CIVV ACT.	386	NAVPRO	202	66	1
86	30 JUL 87	PS2 PROBE	7	944TFG	221	116	
87	1 AUG 87	PT6 TRANS.***	5	ASD	283	45&46	
88	5 AUG 87	MFC	306	33TFW	225	4&6	
89	10 AUG 87	PS2 PROBE	8	944TFG	222	115	
90	12 AUG 87	A/I VAL.	313	33TFW	227	184	
91	14 AUG 87	MFC	314	33TFW	228	8	
92	20 AUG 87	DIV SEAL	339	33TFW	235	149	
93	24 AUG 87	DIV SEAL	348	33TFW	236	153	

94	29 AUG 87	FLEX-SHAFT	1	DET 4	219	198	
95	1 SEPT 87	MFC	486	NAVPRO	241	7	1
96	1 SEPT 87	A/I VAL	480	NAVPRO	239	195	1
97	2 SEPT 87	PS2 PROBE	487	NAVPRO	242	123	1
98	2 SEPT 87	A/I VAL	488	NAVPRO	243	188	1
99	5 SEPT 87	PS2 PROBE	384	33TFW	260	111	
100	8 SEPT 87	MFC	383	33TFW	347	5	
101	11 SEPT 87	EDU	21	944TFG	265	50	
102	12 SEPT 87	ENPT	9	DET 4	331	177	
103	15 SEPT 87	FLAME HOLDER	389	33TFW	262	147	
104	16 SEPT 87	PT6 TRANSDUCER	397	33TFW	264	39	
105	16 SEPT 87	EDU BRD.	391	33TFW	263	53	
106	16 SEPT 87	PS2 PROBE	394	33TFW	267	112	
107	16 SEPT 87	A/I VAL	511	NAVPRO	259	193	1
108	16 SEPT 87	A/I VAL	510	NAVPRO	381	192	1
109	16 SEPT 87	EDU BRD.	399	33TFW	269	57	
110	17 SEPT 87	INTER. BRD (DEEC)	398	33TFW	268	43&56	
111	23 SEPT 87	A/I VAL	10	DET 4	277	18	
112	1 OCT 87	PS2 PROBE	425	33TFW	21	113	
113	8 OCT 87	P&S CABLE	567	NAVPRO	28	133	1
114	14 OCT 87	DEEC	440	33TFW	292	4	
115	14 OCT 87	TT2 SENS****	430	33TFW	285	14	
116	14 OCT 87	A/I VAL	451	33TFW	307	182	
117	15 OCT 87	P6 PRESS SENS***	432	33TFW	287	47	
118	15 OCT 87	CONVERTER BRD***	431	33TFW	286	44	
119	15 OCT 87	DIV. SEAL	434	33TFW	298	160	
120	15 OCT 87	DIV. SEAL	434	33TFW***	290	162	
121	15 OCT 87	RCVV ACT.	433	33TFW	288	61	
122	24 OCT 87	PS2 PROBE	521	33TFW	340	122	
123	26 OCT 87	FLAME HOLDER	453	33TFW	305	139	
124	26 OCT 87	DIV SEAL	455	33TFW	303	164	
125	26 OCT 87	DIV SEAL	456	33TFW	302	166	
126	29 OCT 87	ENPT	464	33TFW	325	178	
127	3 NOV 87	MFC	604	NAVPRO	308	3	1
128	4 NOV 87	FLAME HOLDER	472	33TFW	315	141	
129	10 NOV 87	CABLE	487	33TFW	323	129	
130	12 NOV 87	DIV. SEAL	495	33TFW	328	167	
131	13 NOV 87	DIV. SEAL	497	33TFW	330	168	
132	16 NOV 87	PLA/RES	482	33TFW	311	19	
133	19 NOV 87	FLAME HOLDER	505	33TFW	332	143	
134	22 NOV 87	PS2 PROBE	542	33TFW	350	97	
135	23 NOV 87	DIV. SEAL	517	33TFW	336	169	
136	23 NOV 87	CABLE	514	33TFW	335	126	
137	24 NOV 87	FTIT PROBE	52	944TFG	363	82	
138	24 NOV 87	FTIT PROBE	53	944TFG	364	84	
139	24 NOV 87	FTIT PROBE	520	33TFW	338	85	
140	24 NOV 87	FTIT PROBE	519	33TFW	337	83	
141	30 NOV 87	DIV. SEAL	526	33TFW	339	170	
142	30 NOV 87	DIV. SEAL	525	33TFW	346	171	

143	30 NOV 87	FLAMEHOLDER	524	33TFW	345	145	
144	1 DEC 87	DIV. SEAL	532	33TFW	341	158	
145	2 DEC 87	LOD	538	33TFW	348	74	
146	7 DEC 87	FTIT SENS***	556	33TFW	361	87&99	
147	8 DEC 87	A/I VAL	552	33TFW	356	180	
148	10 DEC 87	COUPLING	670	33TFW	355	77	1
149	17 DEC 87	EDU BRD.	565	33TFW	379	55	
150	19 DEC 87	A/I VAL	1	944TFG**	389	197	
151	21 DEC 87	FLAMEHOLD	568	33TFW	369	146	
152	23 DEC 87	DIV SEAL	570	33TFW	367	150	
153	28 DEC 87	DIV SEAL	576	33TFW	366	152	
154	4 JAN 88	PT6 PRES****	61	33TFW	408	40	
155	4 JAN 88	CONV. BRD	34	33TFW	387	58	
156	5 JAN 88	PS2 PROBE	14	33TFW	376	98	
157	6 JAN 88	DIV SEAL	26	33TFW	385	154	
158	11 JAN 88	PS2 PROBE	33	33TFW	417	79	
159	14 JAN 88	DIV SEAL	2	ADS	395	157	
160	14 JAN 88	DEEC	51	33TFW	404	38	
161	15 JAN 88	CENC	50	33TFW	403	72	
162	15 JAN 88	PS2 PROBE ***	38	33TFW	393	78	
163	19 JAN 88	DIV SEAL	14	944TFG	413	161	
164	22 JAN 88	DIV SEAL	13	944TFG	412	159	
165	2 FEB 88	DIV SEAL	18	944TFG	421	155	
166	3 FEB 88	DIV SEAL	16	944TFG	415	163	
167	25 FEB 88	COMB CHAMBER	102	33TFW	433	80	

NO.	DISCOVERED DATE	PART	part #	NAT. STK. NO.
1	5 JUN 86	PS2 PROBE	PWA4061830D	2840-1-214-7238
2	10 JUL 86	TT2 SENSOR	PWA351000A	2915-1-224-0778
3	17 JUL 86	DEEC	PWA4068538	
4	5 AUG 86	TT2 SENSOR	PWA351000A	2915-1-224-0778
5	5 AUG 86	MFC	44196	2915-1-214-7309
6	6 AUG 86	MFC-MV/RES	2669873	XXXX-1-226-1048
7	21 AUG 86	DEEC	789900401D01	2915-1-206-0655
8	1 SEP 86	A/I VALVE	3231352	2995-1-227-0751
9	18 SEP 86	A/I VALVE	PWA4066725	2995-1-227-0751
10	2 OCT 86	PS2 PROBE	4061830	2840-1-214-7238
11	13 OCT 86	P&S CABLE	452848	6150-01-233-0914PT
12	14 OCT 86	PS2 PROBE	4061820	2840-1-214-7238
13	20 OCT 86	DEEC (BRD)	MDL7835884	2915-1-224-6581
14	29 OCT 86	PS2 PROBE	4061830	2840-1-214-7238
15	30 OCT 86	PS2 PROBE	PWA4061830E	2840-1-214-7238
16	6 NOV 86	LOD	4066230	2925-1-215-7979
17	11 NOV 86	CIVV	4061376	2995-1-206-7640
18	14 NOV 86	RCVV ACT.	4412933	2995-1-206-7995
19	25 NOV 86	ENPT	PWA4057374F	6620-0-124-9515
20	30 NOV 86	EDU	791130H02D02	6620-1-231-9731
21	5 DEC 86	PS2 PROBE	PWA4061830E	2840-1-214-7239
22	9 DEC 86	MFC	4066012	2915-1-214-7309
23	23 JAN 87	AFC	PWA4067629A	2915-01-217-0177
24	8 JAN 87	PS2 PROBE	406183	2840-1-214-7238
25	16 JAN 87	DEEC	PWA4071099D02	
26	21 JAN 87	A/I VALVE	4066725	2995-1-227-0751
27	8 JAN 87	CABLE	4063830	6150-1-206-5304
28	21 JAN 87	TUBE ASS.	405761401	2840-1-140-1928
29	22 JAN 87	MFC	4066012	2915-1-214-7309
30	29 JAN 87	PS2 PROBE	4061830	2804-1-214-7283
31	2 FEB 87	DEEC	789900H01001	2915-1-206-0655PT
32	10 FEB 87	ENPT	PWA4057374G	6620-0-124-9515
33	23 FEB 87	FTIT PROBE	PWA4065474A	6685-1-203-9203
34	23 FEB 87	SPRAY MAN	4067025	2915-1-240-4313
35	25 FEB 87	STATOR GENERATOR	44838	2925-1-206-7723
36	23 FEB 87	PS2 PROBE	4061830	2804-1-214-7238
37	25 FEB 87	CABLE	452848	6150-1-244-0914
38	25 FEB 87	AFFC	4061379	2915-1-206-0654
39	5 MAR 87	PS2 PROBE	4061830	2840-1-214-7238
40	9 MAR 87	MAIN FUEL PUMP	4065756	2915-1-214-7281
41	16 MAR 87	PS2 PROBE	4061830	2840-1-214-7238
42	25 MAR 87	ENPT	PWA4057374G	6620-0-290-6497
43	30 MAR 87	PS2 PROBE	4061830	2840-1-214-7238
44	2 APR 87	PS2 PROBE	PWA4061830F	2840-1-214-7238
45	3 APR 87	MFC	PWA4066012F	2915-1-214-7309
46	8 APR 87	PS2 PROBE	855FD	2840-1-214-7238

47	9 APR 87	PS2 PROBE	855FD	2840-1-214-7238
48	29 APR 87	DIV. SEAL	4067532	2840-1-234-6083
49	30 APR 87	CABLE	4066946	6150-1-233-0914
50	4 MAY 87	PS2 PROBE	855FD	2840-1-214-7238
51	6 MAY 87	RCVV ACT.	441293	2995-1-206-7995
52	6 MAY 87	RCVV ACT.	441293	2995-1-206-7995
53	6 MAY 87	EDU	4065642D01	6620-1-231-9731
54	6 MAY 87	MFC	PWA4066012F	2915-1-214-7309
55	7 MAY 87	PS2 PROBE	PW4061830F	2840-1-214-7238
56	11 MAY 87	MFC	PWA4066012F	2915-1-214-7309
57	14 MAY 87	DEEC	789900H01	2915-1-206-0655
58	15 MAY 87	PS2 PROBE	4061830E	2840-1-214-7238
59	16 MAY 87	DIV. SEAL	4067532	2840-1-234-6083
60	2 JUN 87	EDU **	45279A	60-1-216-3028
61	2 JUN 87	DEEC	PWA4071099D02	
62	13 JUN 87	PS2 PROBE	4061830	2840-10-214-7238
63	17 JUN 87	EDU BRD.	7852164004	6620-1-224-1082
64	21 JUN 87	PS2 PROBE	855FDREVC	2840-1-214-7238
65	25 JUN 87	RCVV ACT.	PWA4061378H	2995-1-206-7995
66	26 JUN 87	MOPT	4059193	6620-0-290-6505
67	27 JUN 87	MOPT	4059193	6620-1-290-6505
68	1 JUL 87	ENPT	4057374G	6620-1-195-9950
69	6 JUL 87	PS2 PROBE	4061830	2840-1-214-7238
70	10 JUL 87	ENPT	PWA4057374G	6620-0-290-6497
71	10 JUL 87	A/I VAL.	PWA4066725REVE	2995-1-227-0751
72	10 JUL 87	EDU	PWA4060264D03	6620-1-231-9731
73	10 JUL 87	MV/RES	2671642	2915-1-223-1170
74	11 JUL 87	PS2 PROBE	855FD	2840-1-217-7238PT
75	15 JUL 87	INT. I/F BRD	7835884	2915-1-224-6581PT
76	15 JUL 87	ENPT	PWA4057374F	6620-1-124-9515
77	16 JUL 87	A/I VAL.	PWA4066725E	2995-1-227-0751
78	20 JUL 87	CIVV	4412914	2995-1-206-7640
79	20 JUL 87	CIVV ACT.	4412923	2995-1-206-7994
80	20 JUL 87	CIVV	4412914	2995-1-206-7640
81	22 JUL 87	PS2 PROBE	855FD	2840-1-214-7238PT
82	23 JUL 87	EDU BRD.	7852161	6620-1-224-1082
83	29 JUL 87	PLA/RES	HBE351000A	2915-1-222-5690PT
84	29 JUL 87	FLEX-SHAFT	440769	2915-0-352-3874
85	29 JUL 87	CIVV ACT.	PWA4061377F	2995-1-206-7994
86	30 JUL 87	PS2 PROBE	4061830	2840-1-214-7238PT
87	1 AUG 87	PT6 TRANS.***	7862132	XXXX-0-096-7672
88	5 AUG 87	MFC	441396	2915-1-214-7309
89	10 AUG 87	PS2 PROBE	855FD	2840-10-214-7238PT
90	12 AUG 87	A/I VAL.	323135	2995-1-227-0751
91	14 AUG 87	MFC	441396	2915-1-214-7309
92	20 AUG 87	DIV SEAL	4067532	2840-1-060-2793PT
93	24 AUG 87	DIV SEAL	4050493	2840-1-143-3254
94	29 AUG 87	FLEX-SHAFT	440767	2915-0-352-3876
95	1 SEPT 87	MFC	PWA4066012F	2915-1-214-7309
96	1 SEPT 87	A/I VAL	PWA4066725	2995-1-227-0751

97	2 SEPT 87	PS2 PROBE	PWA4061830	2840-1-214-7238
98	2 SEPT 87	A/I VAL	PWA4066725	2995-1-227-0751
99	5 SEPT 87	PS2 PROBE	10630899	2840-1-214-7238
100	6 SEPT 87	MFC	441396	2915-1-214-7309
101	11 SEPT 87	EDU	791130H02003	6220-1-231-9731
102	12 SEPT 87	ENPT	181937	6620-0-214-9515
103	15 SEPT 87	FLAME HOLDER	4068302	2840-1-230-4309
104	16 SEPT 87	PT6 TRANSDUCER	7862132	2915-1-224-7717
105	16 SEPT 87	EDU BRD.	7852161	6620-1-224-1082
106	16 SEPT 87	PS2 PROBE	4061830E	2840-1-214-7238PT
107	16 SEPT 87	A/I VAL	PWA4066725	2995-1-227-0751
108	16 SEPT 87	A/I VAL	PWA4066725	2995-1-227-0751
109	16 SEPT 87	EDU BRD.		6620-1-224-1050
110	17 SEPT 87	INTER. BRD (DEEC)	HS7852122	6620-1-224-1050
111	23 SEPT 87	A/I VAL	3231352	2995-1-227-0751
112	1 OCT 87	PS2 PROBE	4061830E	2840-1-214-7238
113	8 OCT 87	P&S CABLE	PWA4066946	6150-1-233-0914PT
114	14 OCT 87	DEEC	EEC10631	2915-1-206-0655
115	14 OCT 87	TT2 SENS****	351000A	2915-1-224-0778PT
116	14 OCT 87	A/I VAL	323135G	2995-1-227-0751
117	15 OCT 87	P6 PRESS SENS***	7862141	2915-1-224-7718
118	15 OCT 87	CONVERTER BRD***	7807742	2915-1-224-7700
119	15 OCT 87	DIV. SEAL	4067532	2840-1-234-6083
120	15 OCT 87	DIV. SEAL	4067532	2840-1-234-6083
121	15 OCT 87	RCVV ACT.	4412933	2995-1-206-7995
122	24 OCT 87	PS2 PROBE	4061830	2840-1-214-7238
123	26 OCT 87	FLAME HOLDER	4068302	2840-1-230-4309
124	26 OCT 87	DIV SEAL	4067532	2840-1-234-6083PT
125	26 OCT 87	DIV SEAL	4067532	2840-1-234-6083PT
126	29 OCT 87	ENPT	PWA4057374	6620-0-124-9515
127	3 NOV 87	MFC	PWA4066012F	2915-1-214-7309
128	4 NOV 87	FLAME HOLDER	4068302	2840-1-230-4309
129	10 NOV 87	CABLE	446948	6150-1-216-3027
130	12 NOV 87	DIV. SEAL	4067532	2840-1-234-6083
131	13 NOV 87	DIV. SEAL	4067532	2840-1-060-2793PT
132	16 NOV 87	PLA/RES	2672058	2915-1-222-5690
133	19 NOV 87	FLAME HOLDER	4068302	2840-1-230-4309
134	22 NOV 87	PS2 PROBE	4061830	2840-1-214-7238PT
135	23 NOV 87	DIV. SEAL	4057829	2840-1-0602-793
136	23 NOV 87	CABLE	4066946	6150-1-233-0914
137	24 NOV 87	FTIT PROBE	4065474	6685-1-203-9203
138	24 NOV 87	FTIT PROBE	4065474	6685-1-203-9203
139	24 NOV 87	FTIT PROBE	ESD5237C	6685-1-203-9203
140	24 NOV 87	FTIT PROBE	ESD75237C	6685-1-203-9203
141	30 NOV 87	DIV. SEAL	4072683	2840-1-254-3054
142	30 NOV 87	DIV. SEAL	4072683	2840-1-254-3054
143	30 NOV 87	FLAMEHOLDER	4068302	2840-1-230-4309
144	1 DEC 87	DIV. SEAL	4067532	2840-1-143-3254
145	2 DEC 87	LOD	910093	2925-1-215-7979
146	7 DEC 87	FTIT SENS***	ESD5237	6685-1-203-9203

147	8 DEC 87	A/I VAL	323135	2995-1-227-0751PT
148	10 DEC 87	COUPLING	PWA4067183A	3010-1-245-8356
149	17 DEC 87	EDU BRD.	7852164009	6620-1-224-1082
150	19 DEC 87	A/I VAL	4066725	2995-1-227-1751
151	21 DEC 87	FLAMEHOLD	4068302	2840-1-230-4309
152	23 DEC 87	DIV SEAL	4067532	2840-1-234-6083
153	28 DEC 87	DIV SEAL	4067532	2840-1-234-6083
154	4 JAN 88	PT6 PRES****	HS7862132	2915-1-224-7717
155	4 JAN 88	CONV. BRD	7807742	2915-1-224-7700
156	5 JAN 88	PS2 PROBE	4061830	2840-1-214-7238
157	6 JAN 88	DIV SEAL	4057829	2840-1-534-1824
158	11 JAN 88	PS2 PROBE	4068676	4710-1-230-8690
159	14 JAN 88	DIV SEAL	4067532	2840-1-234-6803
160	14 JAN 88	DEEC	789900H02D02	2915-1-206-0655
161	15 JAN 88	CENC	441476	2915-1-206-0648
162	15 JAN 88	PS2 PROBE ***	40688676	4710-1-230-8690
163	19 JAN 88	DIV SEAL	4067532	2840-1-234-6083
164	22 JAN 88	DIV SEAL	4067532A	2840-1-234-6083
165	2 FEB 88	DIV SEAL	4067532A	2840-1-234-6083
166	3 FEB 88	DIV SEAL	4067532A	2840-1-234-6083
167	25 FEB 88	COMB CHAMBER	4064106	2840-1-229-5793

Appendix B: SAS Program

```
options linesize=78;
/* This first SAS routine carries out a MLR on the data
   set found in TEST.DAT.
   we find the basic model...I ask PROC IML to compute
   the Confidence and Prediction Interval.
*/
data mlr;
 infile TEST;
 input REP WAR MON CUM AQC;
proc print;
proc corr;
 var REP WAR MON CUM AQC;
proc rsquare;
 model REP=WAR MON CUM AQC;
/*
 Run a MLR...and output Residuals and Predicted Values
*/
proc reg;
 model REP=WAR MON CUM AQC/ TOL STB;
proc reg;
 model WAR=MON CUM AQC/ TOL STB;
proc reg;
 model MON=WAR CUM AQC/ TOL STB;
proc reg;
 model CUM=WAR MON AQC/ TOL STB;
proc reg;
 model AQC=WAR MON CUM/ TOL STB;

*/  Model choosen incorporates one variable

proc reg;
 model REP=AQC/ R I XPX CLM CLI TOL STB;
 output out=resids r=actres p=predval student=stures ;
 proc print data=resids;

/*
 Produce a Residual Vs. Predicted Value Plot To
 Study Model APTNESS
*/

proc plot data=resids;
 plot stures*predval;
```

```
/* The following SAS IML program is designed to compute a
   Confidence Interval and Prediction Interval for
   a GIVEN BETA PARAMETER and/or a Y value GIVEN some
   X matrix row (X0 vector) for either a Simple Linear
   Regression or Multiple Linear Regression Model.

   The original complete X matrix and Y vector
   are input from a standard SAS data set and then
   used by PROC IML compute make the necessary
   computations.  THE USER MUST SET ALPHA LEVELS and
   SELECT THE BETA PARAMETER and X0 VECTOR of interest.
   See coding below!
*/


proc iml;
   use mlr;
   read all var { "AQC " } into X;
   read all var {"REP"} into Y;
/*
   We need to add a column of 1's into X
*/
   N=NROW(X);       /* N = total number of observations */
   X=J(N,1,1)||X;
   print x;

/* Next we compute X`X inverse and the Betahat Vector */

   C=INV(X`*X);
   BHAT=C*X`*Y;
   K = NROW(BHAT); /* K = number beta paramters to be estimated */

   print c;
   print bhat;

/* Once I have obtained X`X inverse and Betahats I need
   to compute MSE.  Then I can compute confidence bands
   and prediction bands using matrix formulas.
   Note: These formulas will work for SLR
   or MLR.  DON'T FORGET TO USE THEM in EITHER CASE!
*/
   MSE = (Y`*Y - BHAT`*X`*Y)/(N-K);
   print MSE;

   VARB= MSE*C;
   print varb;

 quit;
```

Appendix C: <u>Powerpack Program</u>

```
LET I=0;
LET N=167;
READ B:TEST.PRN;
LET [I]=I+1;
LET [P]=([I]-.5)/N;
LET [Z]= PHIINV([P]);
RETAIN Z,P,RESD;
```

Appendix D: SAS Output Sample with the Dependent Variable Equal to Acquisition Costs

OBS	ACTUAL	PREDICT VALUE	STD ERR PREDICT	LOWER95% MEAN	UPPER95% MEAN	LOWER95% PREDICT
1	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
2	2990.7	6370.3	452.2586	5477.3	7263.3	-2800.5
3	1540.9	4428.3	377.8764	3682.2	5174.4	-4729.4
4	2990.7	6370.3	452.2586	5477.3	7263.3	-2800.5
5	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
6	707.4000	1872.5	367.0119	1147.9	2597.2	-7283.4
7	1540.9	13699.0	932.7400	11857.3	15540.7	4387.8
8	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
9	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
10	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
11	956.0000	3350.8	359.5008	2641.0	4060.7	-5804
12	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
13	1633.8	4630.2	383.3732	3873.3	5387.2	-4528.3
14	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
15	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
16	2111.5	5635.4	418.9564	4808.2	6462.6	-3529.2
17	2347.8	6188.2	443.5155	5312.5	7063.9	-2981
18	542.1000	1762.9	369.0674	1034.2	2491.6	-7393.4
19	248.8000	-2190.2	541.2788	-3259	-1121.5	-11380
20	3671.5	7035.0	486.5190	6074.4	7995.6	-2142.6
21	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
22	26688.0	13078.7	987.2392	11326.9	14830.5	3784.9
23	9370.2	9931.3	665.1966	8617.9	11244.7	710.0343
24	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
25	1540.9	4428.3	377.8764	3682.2	5174.4	-4729.4
26	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
27	928.8000	2952.8	357.7334	2246.5	3659.1	-6201.7
28	100.1000	-10753	1146.6	-13017	-8489.4	-20157
29	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
30	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
31	1540.9	4428.3	377.8764	3682.2	5174.4	-4729.4
32	248.8000	-2190.2	541.2788	-3259	-1121.5	-11380
33	189.1000	-3613.8	630.9954	-4859.7	-2367.9	-12826
34	1184.1	3674.3	362.9829	2957.6	4391.0	-5481
35	687.7000	1882.6	366.8324	1158.3	2606.9	-7273.3
36	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
37	956.0000	3350.8	359.5008	2641.0	4060.7	-5804
38	1972.2	5524.0	414.3974	4705.7	6342.2	-3639.9
39	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
40	3360.1	6772.0	472.5453	5838.9	7705.0	-2402.8
41	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
42	248.8000	-2190.2	541.2788	-3259	-1121.5	-11380

43	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
44	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
45	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
46	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
47	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
48	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
49	956.0000	3350.8	359.5008	2641.0	4060.7	-5804
50	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
51	542.1000	1762.9	369.0674	1034.2	2491.6	-7393.4
52	542.1000	1762.9	369.0674	1034.2	2491.6	-7393.4
53	3671.5	7035.0	486.5190	6074.4	7995.6	-2142.6
54	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
55	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
56	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
57	1540.9	4428.3	377.8764	3682.2	5174.4	-4729.4
58	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
59	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
60	1077.7	3509.3	360.9803	2796.6	4222.0	-5645.7
61	1540.9	4428.3	377.8764	3682.2	5174.4	-4729.4
62	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
63	1298.3	3947.3	367.3092	3222.1	4672.5	-5208.7
64	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
65	542.1000	1762.9	369.0674	1034.2	2491.6	-7393.4
66	266.2000	-1875.1	522.6759	-2907.1	-843.13	-11061
67	266.2000	-1875.1	522.6759	-2907.1	-843.13	-11061
68	232.1000	-2522.5	561.4470	-3631.1	-1413.9	-11717
69	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
70	248.8000	-2190.2	541.2788	-3259	-1121.5	-11380
71	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
72	1077.7	3509.3	360.9803	2796.6	4222.0	-5645.7
73	304.8000	-356.62	442.1868	-1229.7	516.4588	-9525.5
74	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
75	1633.8	4630.2	383.3732	3873.3	5387.2	-4528.3
76	248.8000	-2190.2	541.2788	-3259	-1121.5	-11380
77	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
78	2347.8	6188.2	443.5155	5312.5	7063.9	-2981
79	330.7000	-115.29	431.1496	-966.58	735.9982	-9282.1
80	2347.8	6188.2	443.5155	5312.5	7063.9	-2981
81	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
82	1298.3	3947.3	367.3092	3222.1	4672.5	-5208.7
83	747.2000	2306.6	360.8465	1594.1	3019.1	-6848.4
84	268.8000	-1833.2	520.2409	-2860.4	-805.99	-11018
85	330.7000	-115.29	431.1496	-966.58	735.9982	-9282.1
86	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
87	145.1000	-5410.2	753.4529	-6897.9	-3922.5	-14658
88	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
89	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
90	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
91	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
92	223.1000	-3282.8	609.4273	-4486.1	-2079.5	-12489
93	223.1000	-4026.3	658.3692	-5326.2	-2726.3	-13246
94	213.9000	-2938.2	587.3904	-4098	-1778.4	-12139
95	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
96	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
97	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6

98	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
99	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
100	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
101	1077.7	3509.3	360.9803	2796.6	4222.0	-5645.7
102	248.8000	-2190.2	541.2788	-3259	-1121.5	-11380
103	2026.8	5398.1	409.4190	4589.7	6206.5	-3764.9
104	599.0000	2043.3	364.2066	1324.1	2762.4	-7112.3
105	1298.3	3947.3	367.3092	3222.1	4672.5	-5208.7
106	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
107	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
108	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
109	1192.7	4129.2	370.8750	3396.9	4861.5	-5027.3
110	1192.7	4129.2	370.8750	3396.9	4861.5	-5027.3
111	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
112	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
113	956.0000	3350.8	359.5008	2641.0	4060.7	-5804
114	1540.9	4428.3	377.8764	3682.2	5174.4	-4729.4
115	2990.7	6370.3	452.2586	5477.3	7263.3	-2800.5
116	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
117	594.1000	1626.1	371.9037	891.7960	2360.4	-7530.6
118	1786.0	4894.8	391.4610	4121.8	5667.7	-4265.1
119	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
120	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
121	542.1000	1762.9	369.0674	1034.2	2491.6	-7393.4
122	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
123	2026.8	5398.1	409.4190	4589.7	6206.5	-3764.9
124	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
125	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
126	248.8000	-2190.2	541.2788	-3259	-1121.5	-11380
127	26688.0	13078.7	887.2392	11326.9	14830.5	3784.9
128	2026.8	5398.1	409.4190	4589.7	6206.5	-3764.9
129	42.7000	-5986.1	794.1902	-7554.2	-4418	-15247
130	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
131	223.1000	-3282.8	609.4273	-4486.1	-2079.5	-12489
132	747.2000	2306.6	360.8465	1594.1	3019.1	-6848.4
133	2026.8	5398.1	409.4190	4589.7	6206.5	-3764.9
134	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
135	223.1000	-3282.8	609.4273	-4486.1	-2079.5	-12489
136	956.0000	3350.8	359.5008	2641.0	4060.7	-5804
137	189.1000	-3613.8	630.9954	-4859.7	-2367.9	-12826
138	189.1000	-3613.8	630.9954	-4859.7	-2367.9	-12826
139	189.1000	-3613.8	630.9954	-4859.7	-2367.9	-12826
140	189.1000	-3613.8	630.9954	-4859.7	-2367.9	-12826
141	146.3000	-4412.4	684.4330	-5763.7	-3061	-13639
142	146.3000	-4412.4	684.4330	-5763.7	-3061	-13639
143	2026.8	5398.1	409.4190	4589.7	6206.5	-3764.9
144	223.1000	-4026.3	658.3692	-5326.2	-2726.3	-13246
145	2111.5	5635.4	418.9564	4808.2	6462.6	-3529.2
146	189.1000	-3613.8	630.9954	-4859.7	-2367.9	-12826
147	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
148	7.0000	121.1999	420.9078	-709.87	952.2681	-9043.8
149	1298.3	3947.3	367.3092	3222.1	4672.5	-5208.7
150	1627.4	4293.7	374.5546	3554.2	5033.3	-4863.4
151	2026.8	5398.1	409.4190	4589.7	6206.5	-3764.9
152	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154

153	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
154	599.0000	2043.3	364.2066	1324.1	2762.4	-7112.3
155	1786.0	4894.8	391.4610	4121.8	5667.7	-4265.1
156	1452.1	4228.3	373.0394	3491.7	4964.8	-4928.6
157	223.1000	-3282.8	609.4273	-4486.1	-2079.5	-12489
158	236.7000	-2427.1	555.5997	-3524.1	-1330.1	-11620
159	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
160	1540.9	4428.3	377.8764	3682.2	5174.4	-4729.4
161	6445.2	9043.0	606.6457	7845.2	10240.8	-162.49
162	236.7000	-2427.1	555.5997	-3524.1	-1330.1	-11620
163	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
164	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
165	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
166	177.2000	-1967.5	528.0756	-3010.2	-924.88	-11154
167	6632.8	7101.0	490.1017	6133.3	8068.7	-2077.4

OBS	UPPER95% PREDICT	RESIDUAL	STD ERR RESIDUAL	STUDENT RESIDUAL	-2 -1 -0 1 2	COOK'S D
1	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
2	15541.1	-3379.6	4600.5	-.734627	¦ *¦ ¦	0.003
3	13585.9	-2887.4	4607.2	-.626713	¦ *¦ ¦	0.001
4	15541.1	-3379.6	4600.5	-.734627	¦ *¦ ¦	0.003
5	22372.5	13609.3	4536.7	2.9998	¦ ¦***** ¦	0.172
6	11028.5	-1165.1	4608.0	-.252845	¦ ¦ ¦	0.000
7	23010.2	-12158	4527.6	-2.6854	¦ *****¦ ¦	0.153
8	13450.9	-2666.3	4607.4	-.578701	¦ *¦ ¦	0.001
9	13450.9	-2666.3	4607.4	-.578701	¦ *¦ ¦	0.001
10	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
11	12505.6	-2394.8	4608.6	-.519641	¦ *¦ ¦	0.001
12	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
13	13788.8	-2996.4	4606.7	-.650448	¦ *¦ ¦	0.001
14	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
15	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
16	14800.0	-3523.9	4603.6	-.765464	¦ *¦ ¦	0.002
17	15357.3	-3840.4	4601.3	-.834625	¦ *¦ ¦	0.003
18	10919.1	-1220.8	4607.9	-.264931	¦ ¦ ¦	0.000
19	6999.4	2439.0	4590.8	0.5313	¦ ¦* ¦	0.002
20	16212.7	-3363.5	4597.0	-.731684	¦ *¦ ¦	0.003
21	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
22	22372.5	13609.3	4536.7	2.9998	¦ ¦***** ¦	0.172
23	19152.5	-561.08	4574.5	-.122654	¦ ¦ ¦	0.000
24	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
25	13585.9	-2887.4	4607.2	-.626713	¦ *¦ ¦	0.001
26	13450.9	-2666.3	4607.4	-.578701	¦ *¦ ¦	0.001
27	12107.3	-2024	4608.8	-.439161	¦ ¦ ¦	0.001
28	-1349.5	10853.5	4478.2	2.4236	¦ ¦**** ¦	0.193
29	22372.5	13609.3	4536.7	2.9998	¦ ¦***** ¦	0.172
30	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
31	13585.9	-2887.4	4607.2	-.626713	¦ *¦ ¦	0.001
32	6999.4	2439.0	4590.8	0.5313	¦ ¦* ¦	0.002
33	5598.1	3802.9	4579.4	0.8304	¦ ¦* ¦	0.007
34	12829.6	-2490.2	4608.4	-0.54037	¦ *¦ ¦	0.001
35	11038.6	-1194.9	4608.1	-.259312	¦ ¦ ¦	0.000
36	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
37	12505.6	-2394.8	4608.6	-.519641	¦ *¦ ¦	0.001
38	14687.8	-3551.8	4604.0	-.771446	¦ *¦ ¦	0.002
39	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
40	15946.8	-3411.9	4598.4	-.741962	¦ *¦ ¦	0.003
41	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
42	6999.4	2439.0	4590.8	0.5313	¦ ¦* ¦	0.002
43	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
44	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
45	22372.5	13609.3	4536.7	2.9998	¦ ¦***** ¦	0.172
46	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
47	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
48	7219.1	2144.7	4592.4	0.4670	¦ ¦ ¦	0.001
49	12505.6	-2394.8	4608.6	-.519641	¦ *¦ ¦	0.001
50	13385.2	-2776.2	4607.6	-.602525	¦ *¦ ¦	0.001
51	10919.1	-1220.8	4607.9	-.264931	¦ ¦ ¦	0.000

52	10919.1	-1220.8	4607.9	-.264931			0.000
53	16212.7	-3363.5	4597.0	-.731684	*		0.003
54	22372.5	13609.3	4536.7	2.9998		*****	0.172
55	13385.2	-2776.2	4607.6	-.602525	*		0.001
56	22372.5	13609.3	4536.7	2.9998		*****	0.172
57	13585.9	-2887.4	4607.2	-.626713	*		0.001
58	13385.2	-2776.2	4607.6	-.602525	*		0.001
59	7219.1	2144.7	4592.4	0.4670			0.001
60	12664.3	-2431.6	4608.5	-.527631	*		0.001
61	13585.9	-2887.4	4607.2	-.626713	*		0.001
62	13385.2	-2776.2	4607.6	-.602525	*		0.001
63	13103.3	-2649	4608.0	-.574869	*		0.001
64	13385.2	-2776.2	4607.6	-.602525	*		0.001
65	10919.1	-1220.8	4607.9	-.264931			0.000
66	7310.3	2141.3	4593.0	0.4662			0.001
67	7310.3	2141.3	4593.0	0.4662			0.001
68	6671.8	2754.6	4588.4	0.6003		*	0.003
69	13385.2	-2776.2	4607.6	-.602525	*		0.001
70	6999.4	2439.0	4590.8	0.5313		*	0.002
71	13450.9	-2666.3	4607.4	-.578701	*		0.001
72	12664.3	-2431.6	4608.5	-.527631	*		0.001
73	8812.3	661.4239	4601.4	0.1437			0.000
74	13385.2	-2776.2	4607.6	-.602525	*		0.001
75	13788.8	-2996.4	4606.7	-.650448	*		0.001
76	6999.4	2439.0	4590.8	0.5313		*	0.002
77	13450.9	-2666.3	4607.4	-.578701	*		0.001
78	15357.3	-3840.4	4601.3	-.834625	*		0.003
79	9051.6	445.9920	4602.5	.0969025			0.000
80	15357.3	-3840.4	4601.3	-.834625	*		0.003
81	13385.2	-2776.2	4607.6	-.602525	*		0.001
82	13103.3	-2649	4608.0	-.574869	*		0.001
83	11461.6	-1559.4	4608.5	-.338375			0.000
84	7351.7	2102.0	4593.3	0.4576			0.001
85	9051.6	445.9920	4602.5	.0969025			0.000
86	13385.2	-2776.2	4607.6	-.602525	*		0.001
87	3837.5	5555.3	4560.8	1.2180		**	0.020
88	22372.5	13609.3	4536.7	2.9998		*****	0.172
89	13385.2	-2776.2	4607.6	-.602525	*		0.001
90	13450.9	-2666.3	4607.4	-.578701	*		0.001
91	22372.5	13609.3	4536.7	2.9998		*****	0.172
92	5923.4	3505.9	4582.3	0.7651		*	0.005
93	5193.1	4249.4	4575.5	0.9287		*	0.009
94	6262.4	3152.1	4585.2	0.6875		*	0.004
95	22372.5	13609.3	4536.7	2.9998		*****	0.172
96	13450.9	-2666.3	4607.4	-.578701	*		0.001
97	13385.2	-2776.2	4607.6	-.602525	*		0.001
98	13450.9	-2666.3	4607.4	-.578701	*		0.001
99	13385.2	-2776.2	4607.6	-.602525	*		0.001
100	22372.5	13609.3	4536.7	2.9998		*****	0.172
101	12664.3	-2431.6	4608.5	-.527631	*		0.001
102	6999.4	2439.0	4590.8	0.5313		*	0.002
103	14561.0	-3371.3	4604.5	-.732174	*		0.002
104	11198.8	-1444.3	4608.3	-.313406			0.000
105	13103.3	-2649	4608.0	-.574869	*		0.001
106	13385.2	-2776.2	4607.6	-.602525	*		0.001

107	13450.9	-2666.3	4607.4	-.578701	:	*:	:	0.001
108	13450.9	-2666.3	4607.4	-.578701	:	*:	:	0.001
109	13285.8	-2936.5	4607.7	-.637304	:	*:	:	0.001
110	13285.8	-2936.5	4607.7	-.637304	:	*:	:	0.001
111	13450.9	-2666.3	4607.4	-.578701	:	*:	:	0.001
112	13385.2	-2776.2	4607.6	-.602525	:	*:	:	0.001
113	12505.6	-2394.8	4608.6	-.519641	:	*:	:	0.001
114	13585.9	-2887.4	4607.2	-.626713	:	*:	:	0.001
115	15541.1	-3379.6	4600.5	-.734627	:	*:	:	0.003
116	13450.9	-2666.3	4607.4	-.578701	:	*:	:	0.001
117	10782.8	-1032	4607.6	-.223977	:	:	:	0.000
118	14054.7	-3108.8	4606.0	-.674936	:	*:	:	0.002
119	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
120	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
121	10919.1	-1220.8	4607.9	-.264931	:	:	:	0.000
122	13385.2	-2776.2	4607.6	-.602525	:	*:	:	0.001
123	14561.0	-3371.3	4604.5	-.732174	:	*:	:	0.002
124	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
125	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
126	6999.4	2439.0	4590.8	0.5313	:	:*	:	0.002
127	22372.5	13609.3	4536.7	2.9998	:	:*****	:	0.172
128	14561.0	-3371.3	4604.5	-.732174	:	*:	:	0.002
129	3274.9	6028.8	4553.9	1.3239	:	:**	:	0.027
130	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
131	5923.4	3505.9	4582.3	0.7651	:	:*	:	0.005
132	11461.6	-1559.4	4608.5	-.338375	:	:	:	0.000
133	14561.0	-3371.3	4604.5	-.732174	:	*:	:	0.002
134	13385.2	-2776.2	4607.6	-.602525	:	*:	:	0.001
135	5923.4	3505.9	4582.3	0.7651	:	:*	:	0.005
136	12505.6	-2394.8	4608.6	-.519641	:	*:	:	0.001
137	5598.1	3802.9	4579.4	0.8304	:	:*	:	0.007
138	5598.1	3802.9	4579.4	0.8304	:	:*	:	0.007
139	5598.1	3802.9	4579.4	0.8304	:	:*	:	0.007
140	5598.1	3802.9	4579.4	0.8304	:	:*	:	0.007
141	4814.4	4558.7	4571.7	0.9972	:	:*	:	0.011
142	4814.4	4558.7	4571.7	0.9972	:	:*	:	0.011
143	14561.0	-3371.3	4604.5	-.732174	:	*:	:	0.002
144	5193.1	4249.4	4575.5	0.9287	:	:*	:	0.009
145	14800.0	-3523.9	4603.6	-.765464	:	*:	:	0.002
146	5598.1	3802.9	4579.4	0.8304	:	:*	:	0.007
147	13450.9	-2666.3	4607.4	-.578701	:	*:	:	0.001
148	9286.2	-114.2	4603.4	-.024808	:	:	:	0.000
149	13103.3	-2649	4608.0	-.574869	:	*:	:	0.001
150	13450.9	-2666.3	4607.4	-.578701	:	*:	:	0.001
151	14561.0	-3371.3	4604.5	-.732174	:	*:	:	0.002
152	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
153	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
154	11198.8	-1444.3	4608.3	-.313406	:	:	:	0.000
155	14054.7	-3108.8	4606.0	-.674936	:	*:	:	0.002
156	13385.2	-2776.2	4607.6	-.602525	:	*:	:	0.001
157	5923.4	3505.9	4582.3	0.7651	:	:*	:	0.005
158	6765.9	2663.8	4589.1	0.5805	:	:*	:	0.002
159	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
160	13585.9	-2887.4	4607.2	-.626713	:	*:	:	0.001
161	18248.5	-2597.8	4582.7	-.566877	:	*:	:	0.003

162	6765.9	2663.8	4589.1	0.5805	:	:*	:	0.002
163	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
164	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
165	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
166	7219.1	2144.7	4592.4	0.4670	:	:	:	0.001
167	16279.4	-468.21	4596.6	-.101861	:	:	:	0.000

SUM OF RESIDUALS -5.36090E-10
SUM OF SQUARED RESIDUALS 3525843208
PREDICTED RESID SS (PRESS) 3741711365

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VITA

Captain Raymond B. Zaun [redacted] Captain Zaun then attended Alfred University, from which he received the degree of Bachelor of Science in Ceramic Engineering in May of 1983. Upon graduation he entered Officer Training School and was commissioned into the Air Force on 9 September, 1983. He served as reliability and maintainability engineer in the Deputy for Tactical Systems (ASD/TA) System Program Office at Wright-Patterson AFB until entering the School of Systems and Logistics, Air Force Institute of Technology, in May of 1987.

[redacted]

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

ADA201468

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approval for public release, distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S): AFIT/GSM/LSY/88S-29	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: School of Systems and Logistics; 6b. OFFICE SYMBOL (If applicable): AFIT/LSY	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code): Air Force Institute of Technology Wright-Patterson AFB, Ohio 45433-6583	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)

See Box 19

12. PERSONAL AUTHOR(S)
Raymond B. Zaun, B.S., Captain, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
MS Thesis	FROM ______ TO ______	1988 September	100

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Warranty, Regression, Analysis (BT), Engine, Transformations (Mathematics-NT), Cost Analysis, Cost Model
05	03		

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Title: RISK MANAGEMENT ASSOCIATED WITH WEAPON SYSTEM WARRANTIES AND COMPONENT BREAKOUT

Thesis Chairman: Jeffrey J. Phillips, Lt Col, USAF
Instructor in Acquisition Management

Approved for public release IAW AFR 190-1.

WILLIAM A. MAUER 17 Oct 88
Associate Dean
School of Systems and Logistics
Air Force Institute of Technology (AU)
Wright-Patterson AFB OH 45433

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION: UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL: Jeffrey J. Phillips, Lt Col, USAF	22b. TELEPHONE (Include Area Code): 513-255-4845; 22c. OFFICE SYMBOL: AFIT/LSY

DD Form 1473, JUN 86 Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

The objective of this research was to investigate the relationship between component breakout and warranty coverage. To accomplish this objective a review of the literature of these two areas was completed. After this review, unstructured interviews were conducted with several experts in the fields of component breakout and warranties. These experts identified eight factors which influence warranty costs. Data for these factors was obtained from the Recoverable Consumption Item Requirement Computation System (D041) and from data base fourteen of the INFOCEN system. These warranty cost factors were analyzed with the intention of relating these factors back to component breakout.

This analysis was made using regression analyis. The statistical package SAS was used as the primary tool for the regression analysis. The regression analysis used repair and acqusition costs as the dependent variables to be modeled. The regression analysis on these eight factors resulted in a model which included only acquisition costs. This analytical model was tested and found inadequate. To improve the aptness of the model, transformations of the acquistion costs were done. The model produced from these transformations used the square root of the acquisition costs. The new model increased the aptness, but the normal distribution was still not the correct distribution to use for cost data. Therefore, one of the recommendations was to model the data with a statistical distribution other than normal. Another of the recommendations was to investigate the data collected on warranty repair costs.